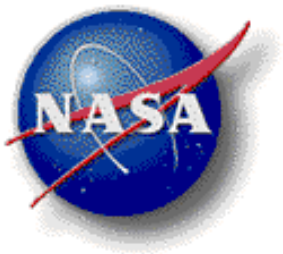
Human Research Program
Program Plan

Revision B
PCN-1

February 5, 2013



National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

Human Research Program

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It is the responsibility of each of the signing parties to notify the other in the event that a plan cannot be met and to initiate the timely renegotiations of the terms of this agreement.

Original Signature on File _____ _____

William H. Paloski, Ph.D. Date
Manager
Human Research Program

Original Signature on File _____ _____

William H. Gerstenmaier Date
Associate Administrator
Human Exploration and Operations
Mission Directorate

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
Baseline	Baseline approved by Kathleen C. Laurini/Manager HRP and Scott J. Horowitz, Associate Administrator, Exploration Systems Mission Directorate	5/31/06
Rev. A	Revised by HRPCB per SLSDCR-HRPCB-08-019 (12/11/08) and DPMC approval (4/13/09)	4/13/09
Rev B	Adjusted for NASA Headquarters (HQ) reorganization merging ESMD with HEOMD and for the addition of the International Science Office to HRP	2/5/13
Rev B PCN-1	Added document number to the header of the document Update Figure 1-1 Updated Figure 3-1 Adjusted document to reflect the transition from SLSD to HHPC Changed CPHS references to IRB Updated Appendix C with WBS additions Updated Appendix F with new Domestic and International Agreements and completed or extended agreements Updated Applicable Documents Added information on the Mishap Preparedness and Contingency Plan Process Added information on the Risk Management Plan and current processes	3/27/14

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1 HUMAN RESEARCH PROGRAM OVERVIEW

1.1 INTRODUCTION

Crew health and performance is critical to successful human exploration beyond low-Earth orbit. The Human Research Program (HRP) investigates and mitigates the highest risks to human health and performance, providing essential countermeasures and technologies for human space exploration. Risks include physiological effects from radiation, hypogravity, and planetary environments, as well as unique challenges in medical treatment, human factors, and behavioral health support. Without HRP results, NASA will face unknown and unacceptable risks for mission success and post mission crew health.

The HRP was established in October 2005 at the Johnson Space Center (JSC) in response to the National Aeronautics and Space Administration's (NASA) decision to focus its research investment on investigating and mitigating the highest risks to astronaut health and performance in support of exploration missions. Strategically, the HRP conducts research and technology (R&T) development that: 1) enables the development or modification of Agency-level human health and performance standards by the Office of the Chief Health and Medical Officer (OCHMO) and 2) provides the Human Exploration and Operations Mission Directorate (HEOMD) with methods of meeting those standards in the design, development, and operation of mission systems.

1.2 PROGRAM GOALS, OBJECTIVES AND METRICS

1.2.1 Goals and Objectives

The HRP is an applied R&T program that contributes to the NASA Strategic Plan, NASA Policy Directive (NPD) 1001.0A, through:

Strategic Goal 1: Extend and sustain human activities across the solar system.

Outcome 1.3: Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low-Earth orbit.

Objective 1.3.2: Develop a robust biomedical research portfolio to mitigate space human health risks.

Strategic Goal 3: Create the innovative new space technologies for our exploration, science, and economic future.

Outcome 3.3: Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.

Objective 3.3.2: Develop and demonstrate the critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.

Strategic Goal 6: Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation, and contribute to a strong national economy.

Outcome 6.1: Improve retention of students in science, technology, engineering, and mathematics (STEM) disciplines by providing opportunities and activities along the full length of the education pipeline.

Objective 6.1.1: Provide quality STEM curricular support resources and materials.
Objective 6.1.2: Provide NASA experiences that inspire student interest and achievement in STEM disciplines.

Outcome 6.2: Promote STEM literacy through strategic partnerships with formal and informal organizations.

Objective 6.2.1: Develop NASA's leadership role in national STEM improvement efforts, as demonstrated by provision of meaningful educator professional development and student experiences, adoption of education technologies, and contributions to STEM education policies and strategies.

The goal of the HRP is to provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. The specific objectives of the HRP are:

1. Develop capabilities, necessary countermeasures, and technologies in support of human space exploration, focusing on mitigating the highest risks to crew health and performance. Enable the definition and improvement of human spaceflight medical, environmental, and human factors standards.
2. Develop technologies that serve to reduce medical and environmental risks, to reduce human systems resource requirements (mass, volume, power, data, etc.) and to ensure effective human-system integration across exploration mission systems.
3. Ensure maintenance of Agency core competencies necessary to enable risk reduction in the following areas: space medicine, physiological and behavioral effects of long duration spaceflight on the human body, space environmental effects, including radiation, on human health and performance and space human factors.

1.2.2 Metrics

Since the HRP provides key information on human health and performance risks to ensure exploration program success, the measure of success is defined by providing high-quality products that meet customer requirements and are delivered to support exploration milestones. The HRP products include: 1) reduction or elimination of human health and performance risks, 2) reduction in uncertainty surrounding human health and performance risks, 3) countermeasures translated to medical operations practice, 4) technologies for monitoring and treatment of adverse outcomes, and 5) information to update the human health and performance standards.

The HRP monitors and tracks the progress of tasks to ensure timely inputs to the OCHMO space flight health standards, exploration programs, medical operations, mission procedures, and flight rule requirements development. The HRP, in conjunction with stakeholders, annually reviews the research progress in closing gaps in technology or knowledge. As gaps are closed, risks are reassessed to verify progress toward meeting the spaceflight health standards for exploration missions. Progress is indicated by changes in the likelihood, consequence, or uncertainty of human health and performance risks. As this data matures, it allows OCHMO and HEOMD managers to accept, mitigate, transfer, or retire the risks.

The Government Performance and Results Modernization Act (GPRMA) of 2010 provides for the establishment of strategic planning and performance measurement in the Federal Government. NASA Procedural Requirements (NPR) 1080.1A, Requirements for the Conduct of NASA Research and Technology (R&T), Section 4.3, Performance Management, is the Agency's response to the GPRMA.

1.3 CUSTOMER-SUPPLIER AND STAKEHOLDER DEFINITION AND ADVOCACY

1.3.1 Customers and Stakeholders

A customer is the primary recipient and ultimate owner of any resultant deliverables. Two organizations are the primary recipients of HRP outcomes and products: OCHMO and HEOMD. HRP research focuses on reducing crew health and performance risks for exploration missions. In addition, HRP research gathers the data necessary to understand and mitigate the long-term health risks to the crew, to allow the update of specific crew health standards for each mission scenario, to support crew selection, and to address any rehabilitation requirements. HRP technology development enables the advancement of medical care and countermeasure systems. The program also develops and matures operations concepts that will inform requirements for the design and operation of space vehicles and habitats needed for exploration missions. HRP products will be incorporated into OCHMO standards, exploration program requirement documents, vehicle designs, and operational processes and documents.

A stakeholder is any entity with an interest in the deliverables. Since the goal of the HRP is to provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration, a key stakeholder is the Astronaut Office at JSC. Flight crewmembers are the equivalent risk takers per NPD 8700.1E, NASA Policy for Safety and Mission Success. The HRP consults with representatives from the Astronaut Office and involves crew personnel in decision making as members of the HRP control boards.

Another HRP stakeholder is the Office of Chief Technologist (OCT). The HRP will work with the OCT to prevent duplication of technology development and coordinate efforts where appropriate. In addition, the HRP will provide the OCT with human systems expertise to assist with their hardware and software development.

1.3.2 Customer and Stakeholder Advocacy

Customers and stakeholders must be active participants in the process of planning, reviewing, and assessing the direction and results of HRP activities. Frequent communication with the

customer will ensure HRP products remain relevant to exploration needs and goals. Customers and stakeholders will provide inputs to the products by reviewing the proposed standards, requirements, countermeasures, and systems solutions to ensure that products are usable, crew health is maintained, operating efficiency is improved, and vehicle and habitat designs are conducive to safe and efficient crew performance. HRP R&T development is conducted to satisfy customer requirements, therefore, the HRP will establish formal customer-supplier agreements (CSAs) to ensure deliverables meet those requirements. These agreements are essential for defining anticipated use, operational concepts, and expectations and for identifying requirements for the R&T development (see HRP 47069 HRP Unique Processes, Criteria, and Guidelines (UPCG), Appendix D). CSAs will also describe the responsibilities for transitioning and infusing the product into the customer's program.

1.4 PROGRAM AUTHORITY AND MANAGEMENT STRUCTURE

1.4.1 Program Authority, Organizational Structure, and Reporting

In October 2005, the NASA Exploration Systems Missions Directorate (ESMD) established the HRP and assigned management of the HRP to JSC. The HRP Program Commitment Agreement, Rev B (PCA) identifies HRP as a Research & Technology Development Program governed by NPR 7120.8, NASA Research and Technology Development Program and Project Management Requirements.

In 2012, the ESMD and Space Operations Mission Directorate were merged to form HEOMD. The HRP Program Manager reports directly to the Director of the Space Life and Physical Sciences Research Applications (SLPSRA) Division of HEOMD. The governing Program Management Council for the HRP is the Agency Program Management Council (APMC). The HEOMD AA delegates the project decision authority to the HRP Program Manager. The "project" description in NPR 7120.8, NASA Research and Technology Program and Project Management Requirements, equates to the "Element" description for the HRP. Thus, the HRP Program Manager authorizes Element implementation with approval of the Element plan. The reporting and management structure, including the program control boards, for the HRP is shown in Figure 1-1.

The HRP is an Agency Program with a Program Office that resides within the Human Health and Performance Directorate (HHPD) at JSC. To facilitate effective integration with other human health programs (Crew Health & Safety and ISS Medical Operations) within HEOMD, the Associate Administrator (AA) delegated cross-program integration responsibilities to the HHPD Director. HRP research implementation plans will be coordinated with Crew Health and Safety and ISS Medical Operations plans to ensure overall effective use of resources to address top human health and performance risks. The HHPD is responsible for ensuring successful transition of HRP products to operational use.

The SLPSRA Division within the HEOMD provides the necessary advocacy, monitoring of program progress, and compliance of the HRP to Agency needs, goals, and objectives. The OCHMO plays a key role as the NASA Health and Medical Technical Authority (HMTA), providing health standards for the development of exploration requirements and by approving HRP countermeasure deliverables for operational use.

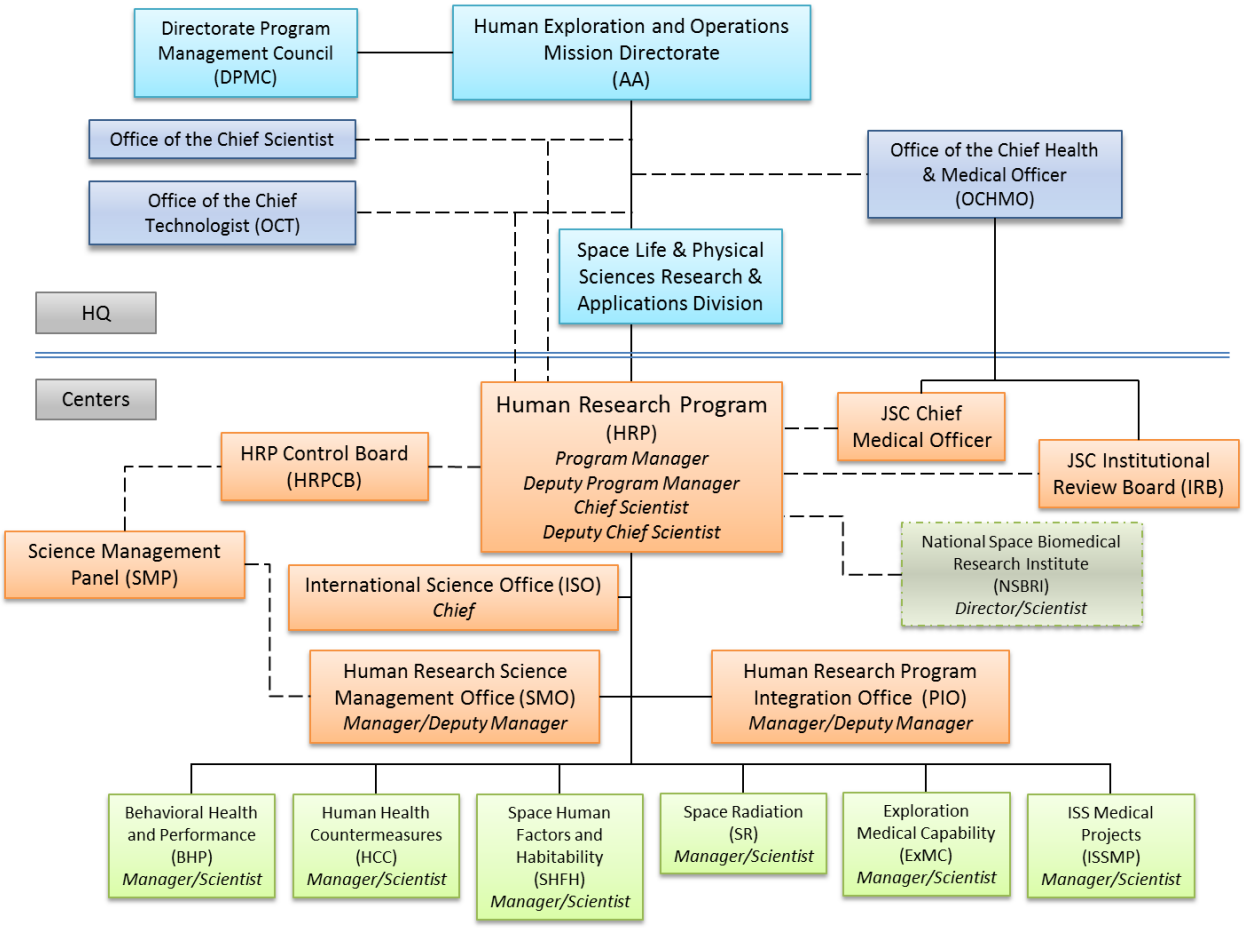


Figure 1-1: Human Research Program Management and Reporting Structure

The HRP organization is designed to support and accomplish the goals of the HEOMD and OCHMO. The Program Manager and Deputy Program Manager lead all aspects of the program. The Chief for the HRP International Science Office (ISO) leads all HRP international R&T interactions. The HRP Chief Scientist and Deputy Chief Scientist lead the science management and coordination. Any references in this document to the Program Manager and Chief Scientist apply to the deputy positions as well, unless specifically identified for the Deputy Program Manager or Deputy Chief Scientist. Three offices, the ISO, the Science Management Office (SMO) and the Program Integration Office (PIO), support program and science management and provide integration across the Elements. Six program Elements comprise the HRP and are focused to accomplish specific goals for investigating and mitigating the highest risks to astronaut health and performance. An HRP Element may elect to establish portfolios and projects within its Element in order to focus management and resources across related tasks.

The HRP is a multicenter program that utilizes expertise at JSC, Ames Research Center (ARC), Glenn Research Center (GRC), Langley Research Center (LaRC), Kennedy Space Center (KSC), and Marshall Space Flight Center (MSFC) to accomplish its objectives. Each supporting center

establishes institutional capabilities and processes to meet HRP objectives. HRP leadership is a collaboration of program/portfolio management and science management at the program, Element, and portfolio levels. Both management and science skills are required at each level to implement the program and successfully meet objectives. Personnel collaboration is critical to the success of the HRP. Roles and responsibilities of key management personnel are identified in Section 1.4.6. Roles and responsibilities of key science management personnel are identified in the HRP Science Management Plan (HRP-47053, Rev D).

With program management located at JSC, the HRP utilizes existing JSC tools and processes as much as possible to facilitate program implementation and efficiently use program resources. Since HRP support at JSC is largely matrixed from the HHPD, the HRP uses many HHPD tools and processes, such as for configuration management. Details on the use of JSC and HHPD tools and processes are contained throughout this document.

1.4.2 Management Processes and Documents

The HRP was formulated and initially implemented as an applied research program in accordance with NPR 7120.5C, NASA Program and Project Management Processes and Requirements. In February 2008, HRP was identified as an R&T program per NPR 7120.8, NASA Research and Technology Program and Project Management Requirements. Revision A of the HRP PCA and this Program Plan implemented the transition from NPR 7120.5C to NPR 7120.8.

NPR 7120.8 applies at the program level as well as all of the HRP Elements, except for the ISS Medical Projects (ISSMP). The ISSMP is the HRP Element associated with spaceflight hardware and software development. Thus, the ISSMP is managed in accordance with NPR 7120.5D, NASA Space Flight Program and Project Management Requirements. The remaining HRP Elements are assigned responsibility to investigate and mitigate the highest human health and performance risks composed of gaps and associated tasks. Most tasks are applied research, but some technology development is completed in concert with those research tasks. This parallel flow of activity within an Element correlates to the R&T Portfolio Project per NPR 7120.8. The Elements use the management processes identified for an R&T Portfolio Project as well as any additional content levied per this document.

HRP Element plans were baselined using NPR 7120.5C templates. The HRP assessed the NPR templates and concluded all NPR 7120.8 template requirements are met within the NPR 7120.5C templates. The HRP elected to maintain the NPR 7120.5C templates to provide more specific information on R&T strategy, S&MA, environmental impact, institutional and logistics, physical and information technology security, verification and validation, education and public outreach, and termination review criteria. This content is addressed in this program plan as well as the Element plans. Although documentation may not be formatted per the NPR 7120.8 templates, any content specifically required per NPR 7120.8 is included in the program, Element, plans.

The HRP Documentation Tree (HRP-47054) identifies the principal program documents and associated hierarchy. The HRP Program Plan and budget are approved by the HEOMD AA. All other HRP documents are controlled by the HRP Control Board (HRPCB). The HRP utilizes standard documents for program management, such as the Program Requirements Document (PRD) (HRP-47052) and Integrated Master Schedule (IMS). In addition, the HRP utilizes

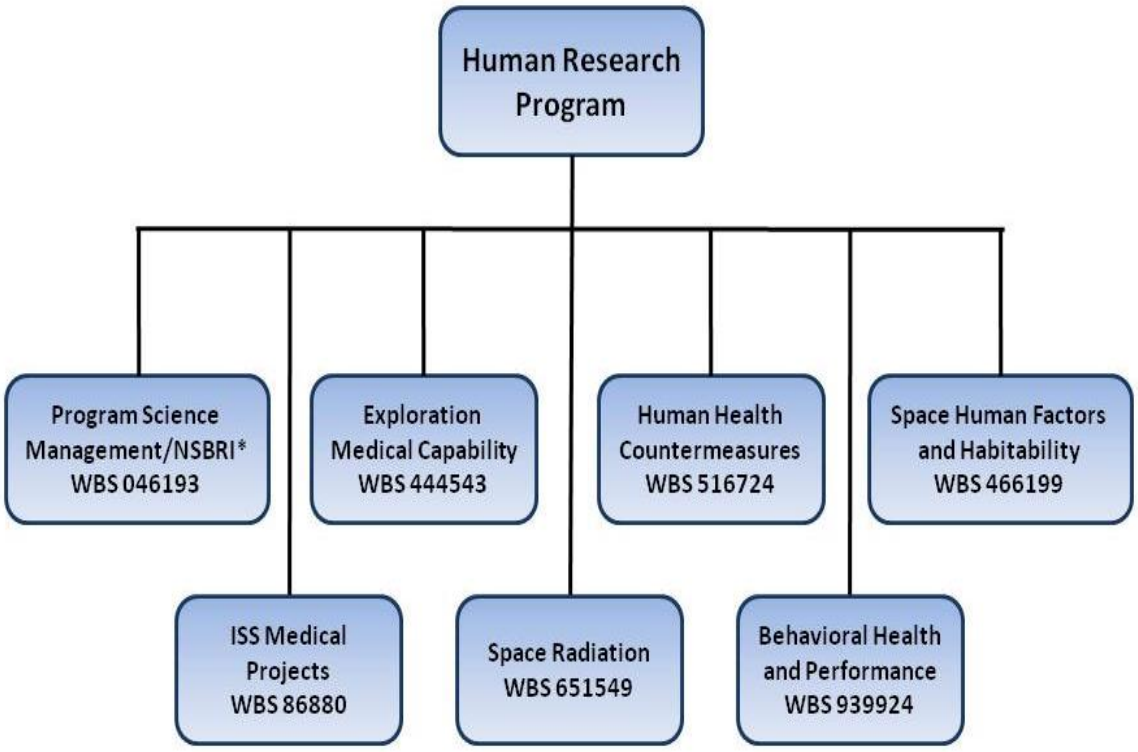
unique documents to facilitate management of the science and research content, which are the HRP Science Management Plan (HRP-47053, Rev D), Evidence Reports, and HRP Integrated Research Plan (IRP) (HRP-47065, Rev C).

The HRP Science Management Plan describes the policies and processes utilized in the science management of the HRP. The Evidence Reports are a collection of evidence-based review articles that provide a current record of the state of knowledge from research and operations for each of the identified human health and performance risks within the HRP. The IRP is a comprehensive document that defines projected R&T required for both flight and ground experiments and facilities. These three documents are key management tools for resource allocation across the program and product delivery to customers.

The IRP is electronically available as a database via the Human Research Roadmap (HRR): http://humanresearchroadmap.nasa.gov/. In the HRR database, a user can more easily search for such items as gaps associated with a risk, the tasks associated with a given gap, the cross-integration of a task across multiple gaps or risks, and deliverables associated with a gap or task.

1.4.3 Program Work Breakdown Structure

The top-level Work Breakdown Structure (WBS) for the HRP is shown in Figure 1-2. The complete WBS (through Level 4) is presented in Appendix C.



*Note: The NSBRI cooperative agreement is funded within the Program Science Management WBS.

Figure 1-2: Human Research Program Work Breakdown Structure

Each WBS item corresponds to one of six HRP Program Elements or the HRP Program Science Management/NSBRI WBS. These WBS elements are described in Section 1.4.4. The tasks within the Program Science Management/NSBRI WBS are described in Section 1.4.5. Although the NSBRI is funded within the Program Science Management/NSBRI WBS, scientific and technical work is performed across several WBS Elements within the HRP.

1.4.4 HRP WBS Definition

1.4.4.0 WBS Level 0, Human Research Program

Program Code 317V: Human Research Program

This WBS element encompasses all the work required to organize, plan, lead, and control the activities assigned to HRP. Activities include establishing team norms, values, and leadership philosophies, as well as advocating external to the program for resources to achieve HRP goals. Activities also include working with customers to set HRP goals and communicating these goals to the program.

This WBS element shall provide the necessary program controls to ensure proper oversight of HRP operations. This shall include business systems and analysis and performance measurement systems and analysis. This WBS element shall also account for all work required to provide periodic reviews of the activities within HRP, which includes both internal reviews across the program as well as external reviews of HRP activities for adequacy and compliance.

1.4.4.1 WBS Level 1, Program Elements

The program is divided into six major Elements (Figure 1-2) and Program Science Management/NSBRI, which are described in the following subsections. These Program Elements provide the knowledge and capabilities to conduct research to address the human health and performance risks as well as advance the readiness levels of technology and countermeasures to the point of transfer to the customer programs and organizations. An Element consists of the aggregation of related portfolios and research tasks focused toward developing products that reduce risks to the crew. As previously stated, an Element is managed as an R&T portfolio project, but may elect to establish formal projects within its Element. A project is characterized as an integrated set of tasks undertaken to deliver a product or set of products to a designated customer on a specified date.

Each Element is managed with R&T development expertise provided by JSC, ARC, GRC, LaRC, KSC, NSBRI, academic institutions, and other Agencies or organizations identified in the Element plans. Management and technical resources at each center supporting the Element are included in each Element WBS.

WBS 4286.046193: Program Science Management/NSBRI

The Program Science Management (PSM) WBS element accounts for the personnel and operations of the HRP program management and scientist positions. This WBS includes PIO, SMO, ISO and HRP Education and Outreach Office (HRPEO), which collectively provide key integration of activities across the HRP in support of the Program Manager, Chief Scientist, and Elements. This WBS also includes the ARC Point of Contact (POC) and budget support.

The HRP partners with the NSBRI to investigate the physical and psychological challenges of long duration spaceflight. As a research consortium, the NSBRI is another forum to bridge the research, technical, and clinical expertise of the biomedical community with the scientific, engineering, and operational expertise of NASA. The HRP and NSBRI management are closely integrated to ensure that activities align with program objectives. The NSBRI research products are integrated with each Element to contribute to the mitigation of human health and performance risks. Although the NSBRI supports multiple Elements within the HRP, the cooperative agreement is centrally funded under this WBS.

WBS 4286.444543: Exploration Medical Capabilities (ExMC)

This WBS element is responsible for establishing requirements for crew health maintenance during exploration missions, developing treatment scenarios, extrapolating from the scenarios to health management modalities, and evaluating the feasibility of those modalities for use during exploration missions. The ExMC Element is also responsible for the technology and informatics development that will enable the availability of medical care and decision systems for exploration missions.

Exploration objectives present significant new challenges to crew health care capabilities. These challenges include the hazards created by the terrain of lunar or planetary surfaces that may be difficult to traverse during exploration, the effects of gravity transitions, low-gravity environments, and limited communications with ground-based personnel for diagnosis and consultation. Each challenge has associated medical implications and medical requirements and technologies to ensure safety and success.

The major deliverables for the ExMC Element are inputs to medical standards for crew selection and retention criteria; requirements for medical equipment, clinical care capabilities, medical equipment technology development; and medical informatics.

The GRC, ARC, LaRC, and NSBRI contribute technology development and clinical care expertise to the ExMC Element.

WBS 4286.466199: Space Human Factors and Habitability (SHFH)

This WBS element is focused on the human system in space environments: how do humans interface with spacecraft systems and what environmental and habitation factors are essential to maintain crew health and performance? The SHFH Element has three focus areas: Space Human Factors Engineering (SHFE), Advanced Environmental Health (AEH), and Advanced Food Technology (AFT).

The major deliverables for the SHFH Element are:

- inputs to the NASA Space Flight Human System Standard, NASA-STD-3001 Volume 1 & 2 and the associated Human Integration & Design Handbook (HIDH);
- validated models for predicting the effects of interface designs on human performance, such as the overall acoustics environment;
- methods for measuring human and human-system performance;
- design concepts for and evaluations of advanced crew interfaces and habitability systems;
- inputs to environmental health standards and research needed to inform requirements for exploration spacecraft and habitats; and

- extended shelf life foods with improved nutritional content, quality, reduced mass, and higher packaging efficiency to facilitate trash management.

The ARC and NSBRI contribute to the SHFH Element.

WBS 4286.516724: Human Health Countermeasure (HHC)

The WBS element is responsible for understanding the physiological effects of spaceflight and developing countermeasure strategies and procedures. The Element provides the biomedical expertise for the development and assessment of medical standards and vehicle and spacesuit requirements dictated by human physiological needs. In addition, the HHC Element develops a validated and integrated suite of countermeasures for exploration missions to ensure the maintenance of crew health during all mission phases.

Countermeasures target human physiology and performance capabilities at risk from spaceflight missions at each stage of mission performance. Preflight countermeasures involve crew selection, physical fitness and exercise, physiological adaptation training, and health stabilization. In-flight countermeasures cover physiological and nutritional health, physical fitness, and mission performance. Postflight countermeasures target rehabilitation strategies.

The major deliverables for the HHC Element are input for the refinement of health and medical standards, validated human health prescriptions, validated exercise system requirements, extravehicular activity (EVA) pre-breathe protocols and physiological requirements for suit development, integrated physiological countermeasures, partial gravity human performance predictions and requirements, and criteria for the agency fitness for duty and crew selection/retention standards. Core laboratories provide the biomedical expertise that enables the development of medical standards, the assessment of the risks to crew health and performance, and the validation of countermeasures.

The ARC, GRC, and NSBRI contribute to the HHC Element, as do international agencies cooperating on joint flight proposals, reduced gravity studies, and collaborative bedrest studies.

WBS 4286.651549: Space Radiation (SR)

This WBS element performs investigations to develop the scientific basis to accurately project and mitigate health risks from the space radiation environment. This knowledge yields recommendations for permissible exposure limits, assessment/projection tools/models of crew risk from radiation exposure, and models/tools to assess vehicle design for radiation protection.

The major deliverables for the SR Element include inputs to standards for radiation health, habitability, and environments; requirements for radiation protection; models and tools to assess and predict risks due to space radiation exposure as well as vehicle design; and strategies to mitigate or treat exposure effects. Although information exists to recommend crew exposure limits and spacecraft design requirements for missions in low-Earth orbit, there is insufficient knowledge of the health effects of radiation, the space radiation environment, and countermeasure efficacy to provide recommendations on crew exposure limits and design requirements for extended lunar and future exploration missions. Therefore, a major focus of the SR Element is basic and fundamental research to expand the knowledge base and reduce the uncertainty inherent in current exposure limits and design requirements.

The SR Element conducts research using accelerator-based simulation of space radiation. The LaRC, ARC, and NSBRI Center of Acute Radiation Research (CARR) contribute to the SR Element.

WBS 4286.868800: International Space Station Medical Projects (ISSMP)

This WBS element is responsible for managing all ISS and ground analog human research activities, including those integrated with operational medical support of the crews, to ensure research tasks are completed. The ISSMP is responsible for all planning, integration, and implementation services for HRP research tasks and evaluation activities requiring access to space, ground analogs, or related resources on the ISS, Soyuz, Progress, Automated Transfer Vehicle (ATV), H-II Transfer Vehicle (HTV), Commercial vehicles, Multi-Purpose Crew Vehicle (MPCV), and ground analogs. This includes support to related preflight and postflight mission activities.

The ISSMP provides and manages the Human Research Facility, enabling generic test and monitoring capabilities for HRP flight studies on the ISS. ISSMP services include operations and sustaining engineering for flight hardware; experiment integration and operation, including individual research tasks and on-orbit validation of next generation on-orbit equipment; medical operations; procedures; crew training concepts; and operation and sustaining engineering for the Telescience Support Center, which provides real-time operations and data services to all HRP flight experiments. This Element integrates the HRP-approved flight and ground analog activity complements and interfaces with external implementing organizations, such as the ISS Payloads Office and International Partners, and analog owner/operators to accomplish HRP objectives.

The ARC contributes to the ISSMP with technical support to experiment management, hardware development, and international partner integration. The KSC provides support for baseline data collection requirements development for future crew vehicles.

WBS 4286.939924: Behavioral Health and Performance (BHP)

This WBS element identifies and characterizes the behavioral and performance risks associated with training, living and working in space, and return to Earth. The BHP Element develops strategies, tools, and technologies to mitigate these risks.

Deliverables for the BHP Element include inputs to the BHP health and medical standards, requirements for behavioral health maintenance, and operational tools for exploration. The BHP Element also delivers knowledge, tools, and technology to detect or prevent:

- performance degradation, human errors, or failures during critical operations resulting from sleep loss, circadian de-synchronization, fatigue or work overload;
- deterioration of morale and motivation;
- interpersonal conflicts or lack of team cohesion, coordination, and communication;
- team and individual decision making, performance readiness factors (fatigue, cognition, emotional readiness), behavioral health disorders, individual selection, crew assignments.

The BHP Element works in close collaboration with its NSBRI partners.

1.4.4.2 WBS Level 2, Management, Research, and Facilities

This WBS element accounts for portfolio management, funded research and awards, and the management of facilities, testbeds, and operations.

1.4.4.3 WBS Level 3, HQ and Center Support

This WBS element accounts for the support given to HRP by NASA HQ and various NASA Centers including ARC, GRC, JSC, KSC, MSFC, and LaRC.

1.4.4.4 WBS Level 4, Element-Defined Sub-Project or Portfolio

This WBS covers HRP Element-defined subprojects and portfolios (see Appendix C). Included in this WBS element are the center specific items such as civil servant labor and travel costs, management reserves, research wedges, conferences and workshops, and project integration and support, indirect procurements, education and outreach, equipment and calibration services, and information technology.

1.4.4.5 WBS Level 5, Element-Defined Groupings within Each Portfolio

This WBS element covers HRP Element-defined groupings within each portfolio such as risks, projects, individual awards, etc.

1.4.5 HRP Program Management Office

Program management covers the HRP Program Management Office personnel and operations, including the Program Manager, Deputy Program Manager, Chief Scientist, Program Clinician, and Deputy Chief Scientist. The Program Clinician provides a direct interface with the Crew Health and Safety Program and medical operations personnel. Program management and supporting offices, PIO and SMO, provide the overall management of the Program and its external interfaces.

1.4.5.1 Program Integration Office

Responsibility for specific program integration efforts is delegated to the HRP PIO. The PIO ensures close coordination of exploration customer needs and program deliverables to meet those needs. The PIO is responsible for program planning, integration, and coordination in support of the HRP Program Manager. The PIO:

a. Develops and maintains the HRP baseline technical requirements with allocations to the Element level, as well as all Program-level documentation.
b. Develops and maintains the baseline PIO budget and schedule. The PIO leads budget formulation and integration of PIO and the integrated PSM input to the annual HEOMD planning, programming, budgeting, and execution (PPBE) process.
c. Leads the acquisition process for procurement of program support tasks. This does not include the selection of science through NASA Research Announcements (NRAs), Announcements of Opportunity (AOs), Broad Agency Announcements (BAAs), etc., which is a science management responsibility conducted per Section 1.4.5.2.

d. Coordinates and integrates HRP program-level reports. The PIO synthesizes reporting products for delivery to external stakeholders in their required format.
e. Ensures HRP product and process quality control by developing and tracking execution of HRP internal processes and facilitating process improvement activities.
f. Establishes and leads or coordinates technical and programmatic trade studies that involve more than one HRP Element. This effort may involve coordination of key interprogram responses.
g. Develops tools and analyses of the program portfolio to help SMO assure proper balance of content and priorities, including the Human Research Roadmap (HRR) development and maintenance.
h. Collects and assesses the integrated programmatic risk posture per the HRP Risk Management Plan (see Appendix E). The PIO assures thorough risk assessment is conducted for all program activities and provides recommendations for elevating and rating of program risks.
i. Provides a formal conduit to the OCT, Advanced Exploration System, and other exploration programs.
j. Seeks out, and formally establishes, collaborative activities that either reinforce HRP core competencies or develop products that help the HRP meet its goals and objectives.

1.4.5.2 Science Management Office

Science management activities comply with NPR 1080.1A, Requirements for the Conduct of NASA Research and Technology (R&T). Responsibility for HRP science management, planning, and coordination is delegated to the Chief Scientist. The SMO supports the Chief Scientist in carrying out these responsibilities. The SMO:

a. Ensures identification and prioritization of the research objectives that reduce the operationally relevant human health and performance risks associated with exploration missions. The prioritized research needs, goals, and objectives are documented in the IRP/HRR. The plan guides allocation of HRP resources to manage the portfolio of ground and flight research, which encompasses both NASA and NSBRI research.
b. Establishes HRP science management policy including appropriate standards for obtaining scientific evidence. The HRP SMO ensures that the integrated research portfolio is properly designed, that measurement techniques are consistent with contemporary standards, and that scientific integrity is maintained via rigorous external community reviews and internal program reviews throughout the life of the program. The HRP SMO develops and evaluates criteria, including termination criteria, for the review of ongoing research.

c. Assures that acquisition approaches achieve appropriate results consistent with programmatic resources and schedules. The HRP SMO requires competitive selection whenever appropriate and helps recruit and retain the highest quality investigators to participate in competitive solicitations, directed studies, and review panels. The NSBRI solicitation processes and investigator recruitment is essential to the process, including assurance that NSBRI research objectives are aligned with HRP goals and objectives as described in the IRP.

d. Supports the development of external relationships with domestic and international agencies to help achieve the research goals and objectives of the program. Domestic agencies include other U.S. Government agencies, academic institutions, and commercial entities.

e. Coordinates procurement of HRP scientific R&T development tasks through appropriate acquisition mechanisms.

f. Coordinates with the PIO to develop tools and analyses of the program portfolio to assure proper balance of content and priorities.

g. Develops and maintains the baseline SMO budget and schedule, integrated with the PSM budget and schedule. The SMO leads budget formulation and integration of the SMO budget and supports integration with PSM input for the annual HEOMD PPBE process.

1.4.5.3 International Science Office

Responsibility for specific international R&T integration efforts is delegated to the HRP ISO. The ISO will manage all HRP interactions with the International Human Health Research for Exploration ISS Expert Working Group Panel (previously known as the ISS Expert Working Group (IEWG) Team 5). The ISO:

a. Reports information to the International Human Health Research for Exploration ISS Expert Working Group on behalf of the HRP.

b. Works with the International Space Life Science Working Group (ISLSWG) and the Multilateral Medical Operations Panel (MMOP) on data sharing, research and operations collaborations.

c. Manages a forum on sharing of investigational results prior to publication.

d. Assesses hardware commonality needs.

e. Supports the standardization of techniques and methods.

f. Leads efforts to resolve barriers to inclusion of Russian, European, Japanese and Canadian subjects for HRP research.

g. Manages an international risk matrix.

h. Coordinates the ISS Human Research Fly-Off Plan.

i. Works towards countermeasures commonality via the International Countermeasure Working Group.

j. Coordinates with the Human Research Multilateral Review Board (HRMRB) on issues.

k. Manages ISS12 (1-year crew missions on ISS) activities, including coordinating a joint science program with Russian partners, with attention to the involvement of the ISS international partners.

1.4.6 Key Personnel Roles and Responsibilities

1.4.6.1 HRP Program Manager

The HRP Program Manager is accountable to the HEOMD AA through the Director of the SLPSRA Division for the performance of the program against established HEOMD objectives. The Program Manager is responsible for program safety, security, cost, schedule, technical performance, and risk. The HRP Program Manager is also responsible for integration, oversight, and assistance to the constituent Program Elements. The HRP Program Manager coordinates program content with the HEOMD, provides leadership, and is responsible for the successful accomplishment of the program that meets the needs of the customers. The Program Manager informs the HEOMD of the establishment or termination of Program Elements.

In addition to the responsibilities defined in NPR 7120.8, the Program Manager:

a. Manages and implements the HRP, including activities performed at participating NASA centers.

b. Supports HEOMD by providing necessary program support to strategic management functions.

c. Integrates program planning and direction, including the program schedule.

d. Develops the program budget and leads the development of the annual HRP PPBE process.

e. Allocates and manages program resources.

f. Manages and implements program outreach activities.

g. Approves Elements and Element Plans, communicating organizational changes to the HEOMD.

h. Manages research, including investigation selection and termination in consultation with HEOMD, and NRA/AO development. Acts as the Selection Official for all research solicitations.

i. Implements international agreements.

j. Implements ISS human research, including flight assignment/manifesting and payload certification for flight.

k. Implements program metrics assessments and reporting.

l. Implements intergovernmental agreements such as those with the National Institute of Health (NIH) and the U.S. Department of Energy (DoE).

m. Implements a programmatic mishap preparedness and contingency plan process (See Section 3.7.3)

n. Implements a programmatic risk management process. (See Section 3.8.)

o. Coordinates HRP center-level implementation activities with supporting center management.
p. Generates an annual assessment of HRP progress in meeting metrics, delivering products, and risk mitigation and closure.
q. Assures communication of HRP results and their relevancy to the operations community.

1.4.6.2 International Science Office Chief

The Chief of the HRP ISO is responsible for managing the responsibilities of the HRP ISO, working closely with the SMO, the ISS Program Office and NASA international partners.

1.4.6.3 HRP Chief Scientist

The Chief Scientist is responsible for science management, planning, coordination and integration as well as maintaining the scientific integrity of the HRP through peer review. The Chief Scientist works closely with the Program Clinician and Element Scientists to ensure operational relevance of research and transition of HRP research products into flight operations. The Chief Scientist has delegated the primary interface for internal HRP science management activities across the Program Elements to the SMO Manager.

The HRP Science Management Plan (HRP-47053, Rev D) details the specific roles and responsibilities of all science positions and the policies and processes utilized for science management within the HRP. Collaboration is critical between management and science personnel utilizing the content of this plan and the HRP Science Management Plan to successfully implement the HRP and meet its objectives.

1.4.6.4 PIO Manager

The PIO Manager leads all program integration functions described in Section 1.4.5.1. The PIO Manager is responsible for the internal coordination of HRP deliverables to external customers and stakeholders and for the integration of program activities involving multiple program Elements. The PIO Manager:

a. Ensures program level documents and processes are developed, maintained, and implemented.
b. Coordinates and integrates HRP products to be provided to external customers and stakeholders.
c. Ensures cross Element coordination and integration occurs for activities involving multiple Elements.
d. Leads the development of the annual PSM PPBE package in support of the Program Manager’s submittal.
e. Ensures that the HRP IMS is developed and maintained.
f. Ensures that the HRP Risk Management Plan is implemented.

1.4.6.5 Element Manager

The HRP Program Manager delegates the implementation, management, and oversight of the constituent portfolios to the Element Managers. The Element Manager:

a. Manages the technical content, including performance and integration of portfolios within the Element, based on the requirements, resources, goals and objectives, and direction provided by the Program Manager.
b. Works closely with the Element Scientist to ensure all Element scientific or technological activities and procurement plan are synchronized with the Element schedule, cost, and milestones and all Element reviews are properly supported.
c. Provides technical, cost, and schedule status reports to the Program Manager.
d. Ensures timely and effective grants management per NPR 5800.1E, Grant and Cooperative Agreement Handbook.
e. Coordinates Element activities across the Agency.
f. Supports the Element Scientist in recommending updates to the IRP.
g. Maintains communication with other Elements to ensure solutions are integrated.
h. Provides direction to the Portfolio Managers as needed.
i. Develops and manages intercenter agreements for Element and portfolio-level support and tasks.
j. Manages the implementation of appropriate international agreements and other Agency-approved agreements and provides technical support for the development of these agreements.
k. Participates in the HRP programmatic risk management process (including that with respect to strategic acquisitions, if applicable).
l. Maintains an Element-level schedule that integrates lower-level portfolio schedules and feeds key milestones in the HRP IMS.

1.4.6.6 Portfolio or Project Manager

If an Element establishes formal portfolios or projects, then each Portfolio or Project Manager is responsible for implementing project activities in accordance with the provided objectives within the cost, schedule, and resources. The portfolio or project manager:

a. Implements the assigned portfolios/projects within budget, schedule, and content guidelines and direction provided by the Element and Program Managers.
b. Works closely with the appropriate scientist to ensure all scientific or technological activities and procurement plans are synchronized with the portfolio/project schedule, cost, and milestones and all reviews are properly supported.
c. Develops plans, work breakdown structures, budgets and schedules, make or buy decisions, statements of work, and requests for proposal.
d. Implements and manages program-approved intercenter task agreements.

e. Approves requirements and interface with flight or ground analog teams to implement the definition, design, development, integration, test, launch (if flight), and operation of experiment hardware and software within the project schedule.
f. Reports status to the Element Manager in a timely manner.
g. Manages appropriate reserves.
h. Develops and implements risk mitigation plans and supports program risk management processes (including those with respect to strategic acquisitions, if applicable).
i. Conducts technical cost/schedule tradeoffs.
j. Informs the Element Manager of deviations to the schedule, budget, and content.
k. Develops and implements portfolio/project related intercenter agreements.
l. Maintains a portfolio/project-level schedule that feeds key milestones in the HRP IMS.

1.4.6.7 Center Point of Contact

The Center Point of Contact (POC) performs program management functions at those NASA centers that participate in the HRP. These functions are in addition to the support provided to the individual program Elements. The Center POC directly interfaces with HRP management. The Center POC:

a. Provides overall coordination of center activities in support of the HRP including center programmatic content, budget, resource assessment and allocation, and staffing.
b. Ensures its NASA Center meets all of its commitments to the HRP.
c. Assists the HRP management team in strategic planning, implementation, and advocacy.

2 HUMAN RESEARCH PROGRAM BASELINE

2.1 PROGRAM REQUIREMENTS/OBJECTIVES

The HRP, in consultation with customers and stakeholders, is responsive to OCHMO and HEOMD needs, goals, and objectives for maintaining crew health and performance during exploration missions. Exploration program documents provide the mission architecture definitions, mission concepts of operations, vehicle, habitat, and spacesuit performance requirements, and other technical information needed to focus the HRP efforts for specific exploration missions. As a program within the HEOMD, HRP objectives are identified in the HRP PCA.

The Chief Health and Medical Officer (CHMO) is the Health and Medical Technical Authority (HMTA) per NPD 1000.3D. The CHMO appoints the HMTA Chief Medical Officer (CMO) designee at each NASA center (as appropriate). The JSC CMO established the Human System Risk Board (HSRB) to ensure a consistent, integrated process is established and maintained for managing human system risks. (See Section 3.1.3 for further descriptions of the HMTA and HSRB.)

The Bioastronautics Roadmap (BR) was used as a starting point to establish the human health and performance risks identified in the PRD (HRP-47052). The BR captured the human system

risks associated with exploration missions. However, it did not capture the level of detail necessary to prioritize across disciplines or compare strategies for a given risk across mission architectures. The JSC CMO developed the Risk Management Analysis Tool (RMAT) to fill this gap and facilitate discussion and decisions by the HSRB.

The RMAT is used as a communication tool to understand human system risks, compare standards, requirements, mitigation strategies, etc., against known mission architectures and resources. The RMAT collects the appropriate information to allow decision makers to develop mitigation strategies for the highest priority human risks for each architecture. The RMAT format reviews medical risks in terms of probability, impact, and proposals for mitigating the risks, and reviews each risk in terms of multiple mission architectures (short-duration Earth-orbital mission, ISS 6-month mission, ISS 12-month mission, short-duration Lunar sortie, long-duration Lunar mission, Near Earth Asteroid mission, and Mars mission).

The HSRB establishes risk priorities based on an assessment of likelihood and consequence. If the board determines there is sufficient evidence for a risk but additional research is required to understand or mitigate the risk, it is assigned to the HRP. The HRP will complete an analysis of the risk and develop a research plan to further understand, inform the standards, or develop mitigation or monitoring strategies for the assigned risk.

The exploration program requirements are merged with applicable HSRB human system risks to form the requirements of the HRP documented in the HRP PRD, HRP-47052. See Figure 2-1. The requirements are further decomposed in the Element plans. The PRD is updated as needed per exploration program revisions and HSRB decisions regarding HRP-applicable human system risks. Performance against requirements is a function of progress in mitigating or eliminating human system risks that is achieved via R&T development tasks and assessed by independent review, approved through the HMTA, and implemented by the OCHMO and HEOMD.

The HRP conducts research, develops countermeasures, and undertakes technology development to inform and support compliance with NASA's health, medical, human performance, and environmental standards. HRP R&T development results in:

- Identification and quantification of the risks associated with human spaceflight for the various exploration missions,
- Delivery of data to support development of, and updates to, applicable human health and performance standards for the various exploration missions,
- Development of countermeasures to provide mission planners and system developers with strategies for mitigating crew health and performance risks,
- Development of technologies to provide mission planners and system developers with strategies for monitoring and mitigating crew health and performance risks,
- Maintenance of NASA's core competency in human health and performance.

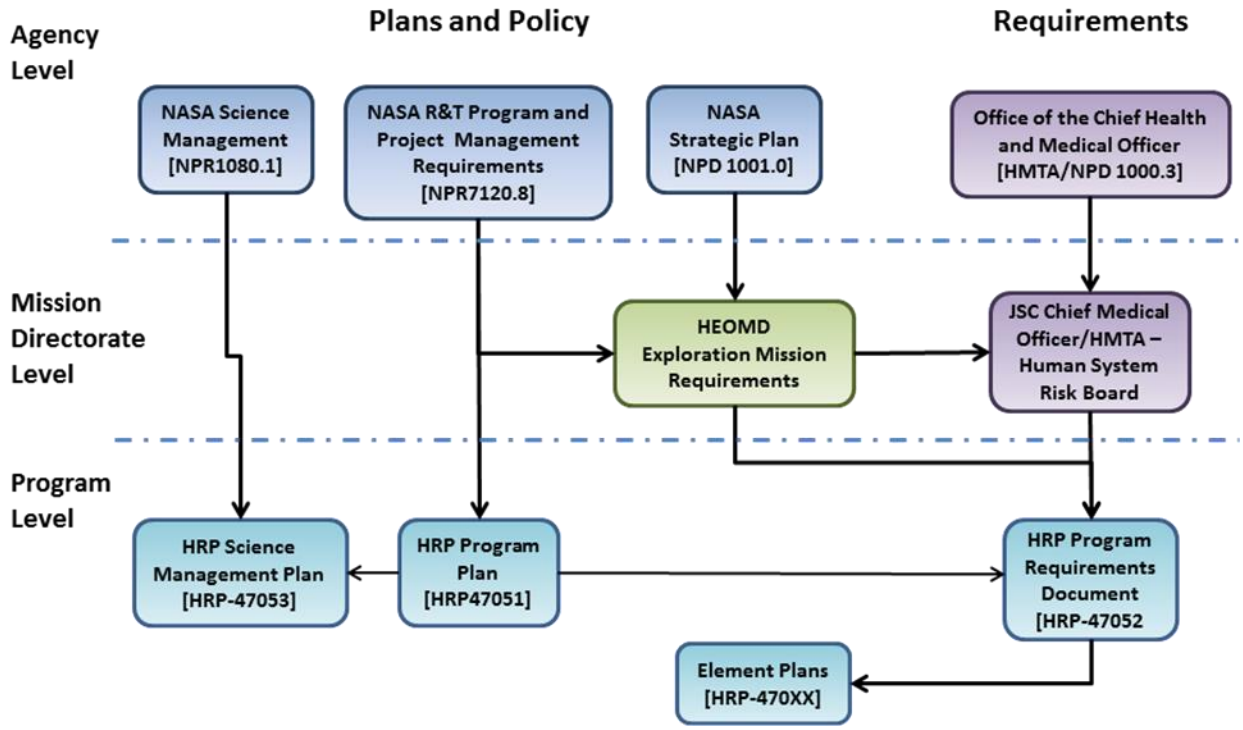


Figure 2-1: HRP Requirements Flow

2.2 PROGRAM SCHEDULE

The key target milestones for the HRP are defined in the HRP PCA and reflected in Appendix D. The schedule is a rollup of significant program, Element activities.

The HRP maintains an IMS with further definition of these key target milestones. HRP management reviews the visibility and control milestones with the Elements on a quarterly basis. The Elements have further detailed schedules that support the milestones. Following each quarterly review, the IMS is updated and approved by the HRPCB.

2.3 PROGRAM RESOURCES

HRP resources are defined in the HRP PCA. The Program Manager makes formal recommendations to HEOMD to establish resource commitments with annual updates as part of the PPBE process defined in NPR 7120.8 and NPD 1000.0A, NASA Governance and Strategic Management Handbook. The HRP Program Manager coordinates center-level resources with the Center POCs. For JSC, the Program Manager coordinates with the HHPD Director for further reporting to the Center Director.

The Program Manager manages program resources to maintain focus on program goals and objectives and to control program costs. The Program Manager implements a budget control process to support Agency full-cost accounting objectives. The HRP Program Manager holds reserves for discretional use within the program.

The budgets for each contributing field center cover the full cost of the assigned responsibilities from the HRP and include ground-based R&T endeavors and flight definition, implementation, and operations activities. Each Element integrates and reports field center budgets as part of its submittal during the annual PPBE process. Budget agreements between contributing centers are documented using Internal Task Agreements (ITAs). The Element PPBE submittal also addresses specific resources necessary to fulfill applicable commitments from international agreements. Changes to budgets are tracked and authorized using Budget Change Directives (BCDs).

3 SUBPLANS

3.1 CONTROLS AND COMPLIANCE

The HRP uses existing HHPD processes and tools for the management and control of the program in order to maintain operating efficiency and reduce costs.

Program management monitors changes affecting the HRP that warrant modifications to the PCA and Program Plan. The Program Manager will prepare modifications and document in the change log, as required. The HEOMD coordinates approval of the PCA and Program Plan through HQ.

3.1.1 Requirements Monitoring and Control

Requirements from a number of sources drive the content and direction of the HRP. The HRP Program Manager is responsible for ensuring that requirements monitoring and change control activities are consistent with agency policies, practices, and procedures and support HEOMD needs, goals, and objectives.

Program reviews will be conducted as defined in Section 3.13 to ensure that program goals and objectives, as well as research and development activities, remain consistent with current HEOMD research and mission needs. Each task will be reviewed to assess the status and continuing relevance of HRP content against the evolving HEOMD research and mission requirements. These reviews may result in adjustments to HRP content to align with updated HEOMD R&T development requirements.

The results of the research conducted within the HRP, as well as evolving exploration requirements and mission definitions, may identify the need for a new task to further understand and mitigate the effects and risks associated with human spaceflight. The HRP will work with the HEOMD and customers and stakeholders to fully define the scope of these tasks, obtain funding, and gain authorization to proceed.

3.1.2 Program Configuration Management

Configuration management of program-level documents, milestones, and Element plans identified in the HRP Documentation Tree (HRP-47054) will be in accordance with the Space Life Sciences Directorate Configuration Control Management Plan, JSC 28330. Configuration of these items will be controlled through the HRPCB. Configuration control of internal Element

implementation documents, schedules and products is delegated to the appropriate Element Configuration Control Board (CCB).

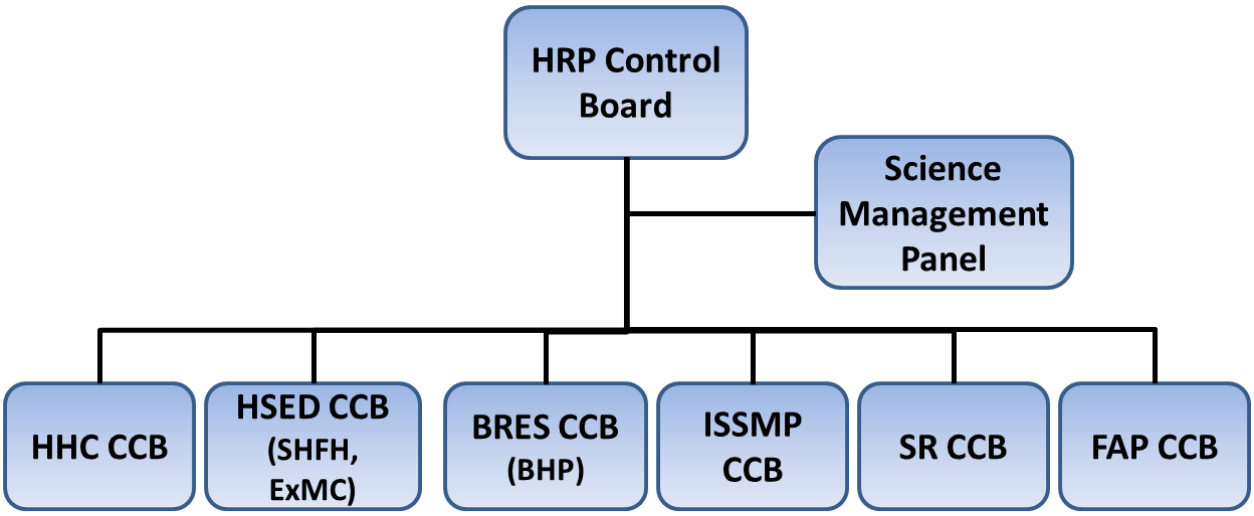
3.1.3 Configuration Control Boards

The HRP uses a series of boards to provide configuration management and review of HRP content. Primary control is through the HRPCB.

3.1.3.1 Human Research Program Control Board

The HRPCB is chaired by the Program Manager and serves as the configuration management and decision-making forum for the HRP. The HRPCB provides the forum for approval of the HRP technical, management, operations, user and integration requirements, science priorities, as well as program schedules and resources. Detailed responsibilities and duties are defined in the HRPCB charter.

The HRPCB uses Element CCBs for controlling HRP internal Element implementation level activities. Elements may elect to use existing JSC/HHPD division CCBs as their Element CCB. The relationship between the HRPCB and the Element CCBs are shown in Figure 3-1. ExMC, in addition to the board listed, uses the SM CCB and a Joint SD/SF CCB for some of their documentation.



CCB	Configuration Control Board
HHC	Human Health Countermeasure
HSED	Human Systems Engineering and Development Division
BRES	Biomedical Research and Environmental Sciences Division
ISSMP	International Space Station Medical Projects
SR	Space Radiation
FAP	Flight Analogs Project

Figure 3-1: Control Boards for the HRP

3.1.3.2 Science Management Panel

The Science Management Panel (SMP) is the HRPCB-chartered forum chaired by the HRP Chief Scientist to facilitate the science management function. Detailed responsibilities and duties are defined in the SMP charter.

3.1.3.3 Health and Medical Technical Authority

The JSC CMO is responsible for implementing the HMTA process for programs managed at JSC. The JSC CMO is an independent entity responsible for assuring compliance and approving deviations to program health and medical technical requirements, processes, and policies. Results from the HMTA process inform JSC, other center, and agency level reviews of program and project progress, including concurrence or non-concurrence on technical issues.

The JSC CMO has the responsibility to review appeals of standards and requirements that are not met in a specific program based on the analysis of their respective owners (program and division configuration and control boards). Appeals of HMTA decisions are reported through independent chains, i.e., program and project managers to the HEOMD AA and the HMTA to the NASA CHMO. The HEOMD AA and CHMO will work resolution of the appeal. If an agreement cannot be reached, then the issue will be escalated to the NASA Administrator for resolution.

3.1.3.4 Human System Risk Board

Human system risks encompass environmental exposures, crew performance issues, biomedical stressors/susceptibilities, the ability to provide medical care, and any other challenges that affect the human as a system. The JSC CMO established the HSRB to ensure a consistent, integrated process is established and maintained for managing human system risks. The HSRB advises the JSC CMO, HMTA delegates, HHPD management, and key HHPD boards concerning the identification, status, coordination, integration, mitigation, and research strategy of all human system risks. The HSRB is the primary board for establishing official recommendations and positions regarding human system risks.

The HSRB is delegated responsibility by the HMTA for two categories of activities:

- Documenting and tracking all risks to the human system associated with spaceflight activities.
- Managing all human system risks and specifying actions to be taken with respect to the risks: accept, mitigate, transfer, watch, research, or retire.

For the HRP, the HSRB establishes what human system risks require research and determines if research results sufficiently reduce, mitigate, or retire a human system risk. The HSRB advises the ISS Program and exploration programs on status and recommendations to disposition human system risks applicable to their programs and/or missions.

3.1.3.5 Engineering and Safety and Mission Assurance Technical Authorities

As a R&T development program focused on investigating and mitigating human health and performance risks, the HRP more directly and frequently interfaces with the HMTA. However,

the HRP also interfaces with the Engineering and S&MA Technical Authorities established per the governance model.

The Office of the Chief Engineer (OCE) ensures that missions are planned and conducted with sound engineering practices and with proper controls and management. OCE requirements are contained within NASA Policy Directives (NPD), NPRs and technical standards. The Office of Safety and Mission Assurance (OSMA) assures the safety and enhances the success of all NASA activities through the development, implementation, and oversight of Agency wide safety, reliability, maintainability, and quality assurance policies and procedures.

Engineering and S&MA Technical Authority are individuals funded independent of programs and projects with formally delegated Technical Authority traceable to the Administrator through the NASA Chief Engineer and Chief, S&MA, respectively. These individuals are identified in center Technical Authority implementation documents.

The HRP interfaces with the technical authorities primarily through development of flight hardware systems, ground facilities for testing, and associated reviews and boards established at the center, HEOMD, and Agency levels. HRP also interfaces with the Engineering and S&MA Technical Authorities when recommending updates to the NASA-STD-3001, Volume 2. Appeals of Technical Authority decisions are reported through independent chains, i.e., HRP Program Manager to the HEOMD AA and the Technical Authority through the OCE or OSMA. The HEOMD AA and OCE or OSMA, as applicable, will work resolution of the appeal. If agreement cannot be reached, then the issue will be escalated to the NASA Administrator for resolution.

3.1.4 Cost and Schedule Controls

The HRP uses regular cost and schedule reporting, as coordinated through the PIO, to measure performance of the Elements against the program baseline. Individual Elements report status at quarterly technical, cost, and schedule reviews (TCSRs). The HRP uses BCDs to re-allocate funding at the Element levels. Changes to control milestones must be approved by the HRP Program Manager.

3.1.5 HRP Strategic Communication Plan

The HRP Strategic Communication Plan (HRP 47081) outlines the strategic communication and outreach efforts undertaken within NASA's HRP. Coordination of this plan with NASA HQ Office of Strategic Communications, Office of Communications Planning, Office of Public Affairs, HEOMD Mission Support Services Office, and JSC Office of Education helps ensure HRP developed products and materials further NASA’s goal to provide timely, clear, accurate, and consistent information to external audiences.

The primary communication paths for the HRP are depicted in Figure 3-2.

3.1.5.1 Formal Communication

Formal communication includes all deliverables as well as management and technical information related to the technical, cost, schedule, and risk performance of the HRP. All formal program communication with the HEOMD, exploration programs, and OCHMO is controlled through the HRP Program Office (including the PIO and SMO) and is approved by the Program

Manager or designee. All formal communication with NSBRI, grantees and contractors is through the Contracting Officer's Technical Representative and the Contracting Officer.

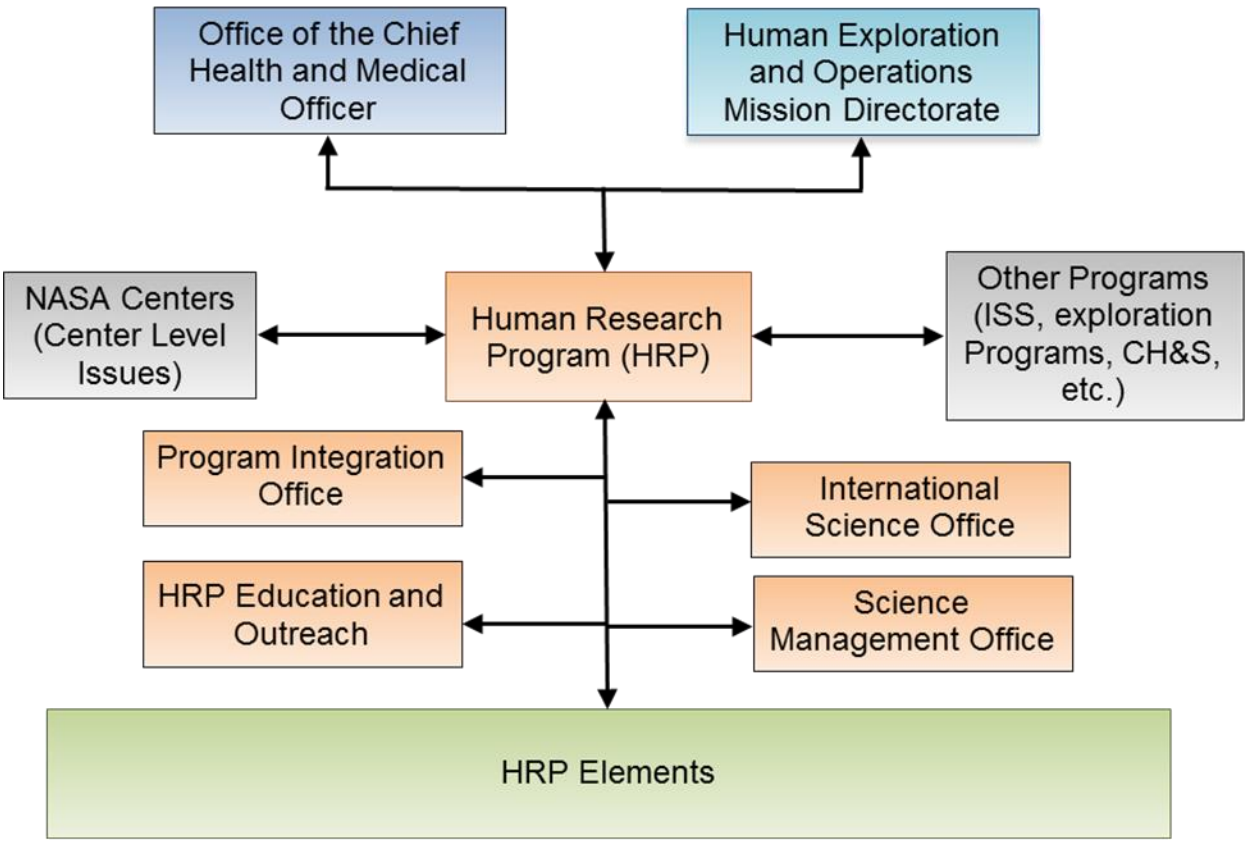


Figure 3-2: HRP Communication Paths

3.1.5.2 Informal Communication

HRP management fosters an environment for open and timely communication by providing regularly scheduled forums, such as the SMP and HRPCB, as well as access for special topic meetings. A weekly tagup is conducted with program and Element managers to convey status across the program. The HRP program offices also flow information and requirements to and from the external organizations to the Elements as necessary. Program and Element management facilitate communication between Elements to ensure HRP objectives are met. This communication provides integration of the output from the various research and development tasks. The HRP program offices and Elements conduct all day-to-day communication with internal and external researchers and support organizations with respect to meeting program objectives. This communication is with principal investigators, research facilities, academia, international support teams, NSBRI, supporting NASA Centers, and other research organizations as well as other program offices. Any issues that may affect cost or schedule or that cannot be resolved at the Element level will be forwarded to the program offices for resolution.

3.1.5.3 Education and Outreach Communication

The HRPEO Project was established by the HRP Program Manager to provide a single focal point for all HRP-related education and outreach efforts. The HRPEO resides within PIO and reports directly to the Program Manager. The HRP mission for communication is to enhance general public awareness of the human challenges of space exploration, as well as, inspire and educate our youth about the Science, Technology, Engineering, and Mathematics (STEM) fields using the real-world experiences at NASA. Communication activities will target formal and informal settings and is committed to using NASA's research in human health to educate the public in STEM as well as increase public involvement in the program through its communication efforts.

3.2 RELATIONSHIPS TO OTHER PROGRAMS AND ORGANIZATIONS

3.2.1 Internal Relationships and Agreements

Internal relationships and agreements are those that exist within NASA between the various programs and centers. Internal agreements that may be concluded with the authority of the HRP Program Manager include those with organizations at the NASA Centers, including other program offices. These agreements shall be formally documented either through the use of Memoranda of Agreement (MOA), CSAs, the PPBE process, ITAs and BCDs. Internal agreements that must be developed under the authority of the HEOMD include agreements with other NASA organizations that require reprogramming of funds. The HRP is not dependent on any NASA activities outside of the HEOMD and OCHMO to fulfill its objectives.

3.2.2 External Relationships and Agreements

External relationships and agreements are those that exist with organizations outside NASA. External agreements that may be concluded under the authority of the Program Manager include partnering opportunities as solicited through internal calls for proposals, directed research projects, AOs, and BAAs. External agreements that must be developed under the authority of the HEOMD include agreements with other federal agencies and United States industries for the purpose of sharing research facilities, multi-user hardware, and collaboration on research activities of mutual interest. The HEOMD also authorizes agreements with international space agencies for the purpose of sharing research facilities, multi-user hardware, and collaboration on research activities of mutual interest. The current list of external agreements is presented in Appendix F.

3.3 BUDGET AND ACQUISITION STRATEGY

The HRP Elements use the NASA PPBE process to generate baseline budgets.

The HRP uses available NASA and HEOMD acquisition methods, such as AOs, BAAs, NRAs, Cooperative Agreement Notices (CANs), Small Business Innovation Research (SBIR) solicitations, open innovation calls, internal calls for proposals, Requests for Proposals (RFPs), Requests for Quotes (RFQs), and Requests for Information (RFI) to acquire R&T development support. In addition, acting in partnership with NASA, the NSBRI provides access to the external research community by supporting research via national solicitations.

Directed research is another acceptable acquisition method. Directed research can involve in-house, external, or a combination of both researchers. The HRP uses directed research as an acquisition method for obtaining selected research data and technology development when:

a. There is insufficient time for solicitation. In certain cases, NASA must define scientific activities in a short time (e.g., because of the emergence of new opportunities to carry out activities in space). When this is the case, use of a directed study may be the only practical way to respond.

b. The research is highly constrained. In this case, the Element or project requires constrained data gathering and analysis that is more appropriately obtained through a well-defined solicitation using a Request for Proposal (RFP) or by a non-competitively developed proposal (e.g., the research task may involve extensive operational practices and associated operational personnel who must be heavily involved in the development of the study design).

Participating NASA Centers also utilize competitive contracts for procurement of support to intramural project tasks. The centers have multiple options for procurements and select the optimal procurement method based on the Agency policy of the widest possible use of competitive processes.

Regardless of the acquisition method, the review and selection of science is in accordance with NASA policies, which include incorporation of a risk-informed decision process of identification, analysis, and management of programmatic, institutional, technical, cost, schedule, environmental, safety, management, industry, and external policy risks that might jeopardize the success with which NASA executes its acquisition strategies. Furthermore, the selection of science is merit reviewed per the HRP Science Management Plan, HRP-47053, Rev D.

3.4 RESEARCH AND TECHNOLOGY STRATEGY

3.4.1 Basic and Applied Research

The HRP performs research tasks that focus on the reduction of the most significant risks to crew health and performance to enable exploration missions and that increase the knowledge base to inform the development of human health standards and human support systems. Tasks include basic and applied research to inform crew health and medical standards, develop human-system integration, and guide the development of human health countermeasures.

Basic and applied research includes the test and validation of hypotheses, formulation of countermeasure concepts and initial demonstration of efficacy, clinical trials/testing, and finally, validation and delivery for operational implementation.

The OCHMO transition to medical practice process, as defined in NPR 8900.1, Appendix D, Transition to Medical Practice, and the HRP transition to operations process, as defined in HRP-47069, are used to review and approve HRP deliverable countermeasures and technologies prior to their operational use.

3.4.2 Countermeasure Development

The HRP nominally begins a countermeasure development at Countermeasure Readiness Level-4 (CRL-4) and develops the selected countermeasure to CRL-7 or -8. At this point, the HRP transfers the countermeasure to the implementing organization for incorporation. For some Elements, Space Radiation for example, countermeasure development must begin at much lower CRLs and are thus developed to CRL-6 prior to transition. See Figure 3-3.

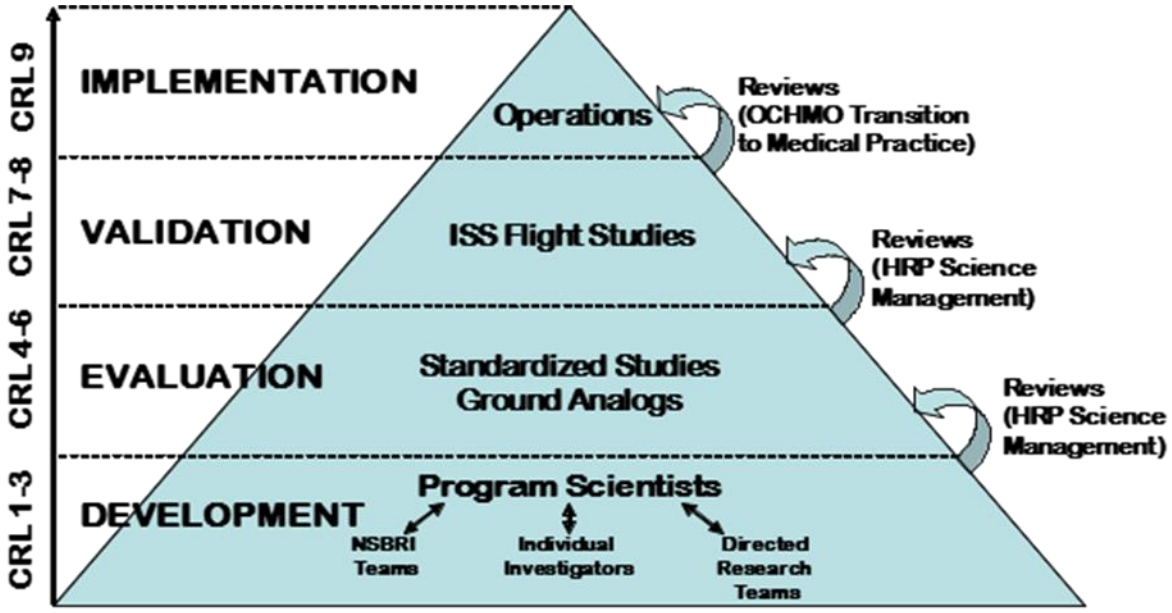


Figure 3-3: Countermeasure Development Process

3.4.3 Technology Development

The HRP nominally develops critical human system technologies to Technology Readiness Level-6 (TRL-6) by the time of the applicable Preliminary Design Review. See Figure 3-4. However, in cases where the individual technology requires demonstration in the spaceflight environment, it may be developed to TRL-7 or 8. The final TRL delivered will be determined in the CSA. Technology development may include those tasks needed to mature countermeasures as defined in Section 3.4.2. The HRP utilizes the ISS and ground testbeds to integrate and demonstrate technologies. Technology deliverables will be transitioned to the customer for final maturation, development, and insertion into the flight program. The HRP works with the OCT to ensure that human health technology development activities are complementary and avoid duplication across HRP and OCT portfolios. An HRP Technology Pipeline is maintained to illustrate the HRP technology development plan embedded within the IRP.

Before technologies are delivered, the HRP completes an infusion process, which includes assessment of TRLs and successful completion of development control gates. This includes an independent technical review with the participation of the intended customer. This review will provide early visibility of technology capabilities to the program and stakeholders, enabling the identification of preferred technology insertion paths. An internal review of the technology development status will be conducted to assess its readiness for delivery to the targeted customers.

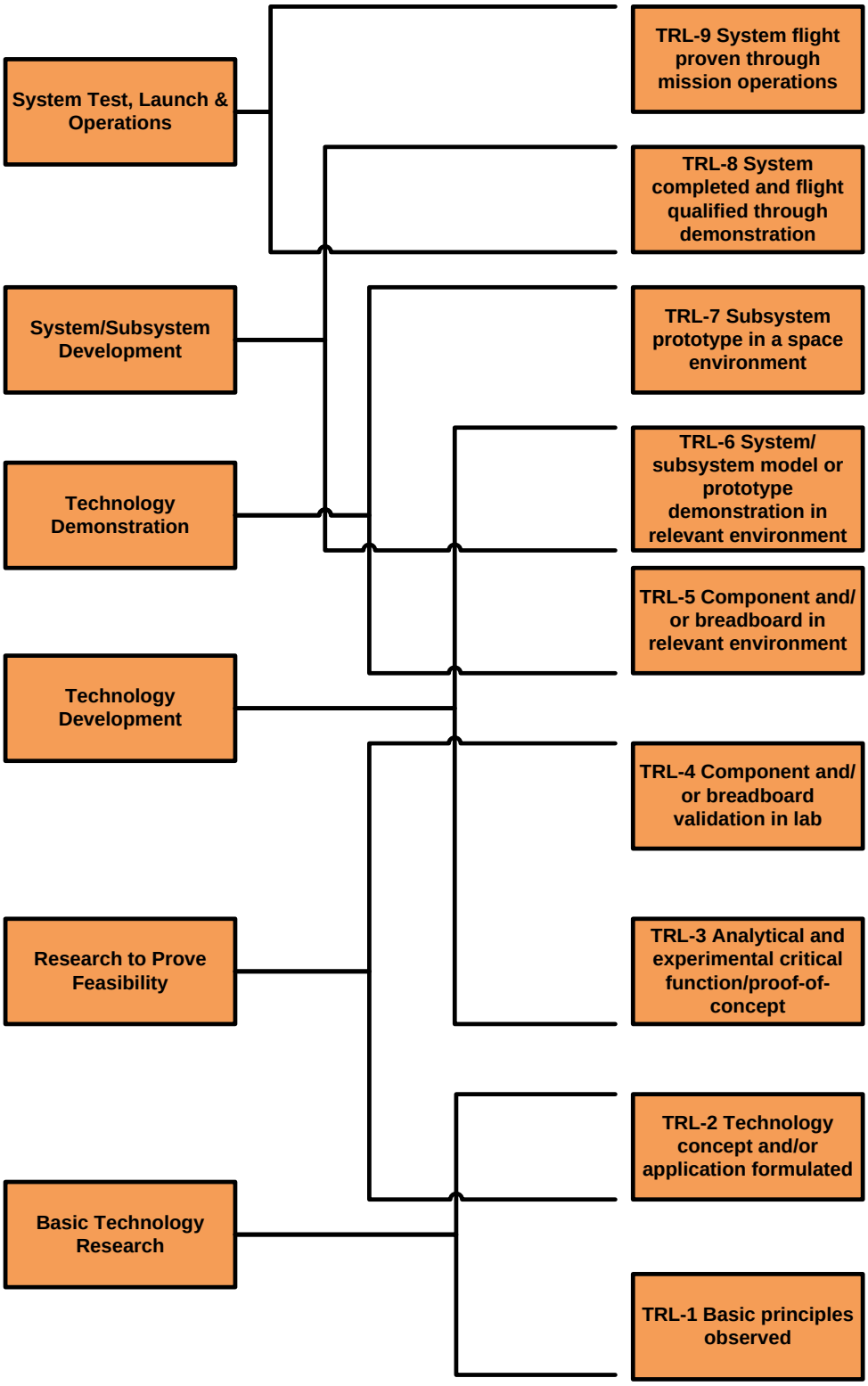


Figure 3-4: Definition of Technology Readiness Levels

3.5 COOPERATION AND COMMERCIALIZATION

The JSC Strategic Opportunities and Partnership Development (SOPD) Office will support the HRP to identify and evaluate commercial opportunity options. As applicable, the JSC SOPD Office works with the HRP to develop specific commercialization partnership and/or technology transfer opportunities. The SOPD Office support of partnership development includes industry market analysis, search for and connection to potential partners, and partnership due diligence and evaluation. Agreement negotiation and definition are performed within the JSC Directorate by the delegated representative of the agreement's sponsoring organization. Similarly, the supporting NASA Centers use their own commercialization and technology transfer organization, as appropriate, in support of their content.

3.6 DATA MANAGEMENT AND DISTRIBUTION

The documents developed under the HRP are stored in HRP managed databases for configuration management and are available to the general public in accordance with JSC policy. For cross-center integration, the HRP utilizes a SharePoint website and an HEOMD-provided storage location and tools for review documents and schedules.

A goal within the HRP is to maximize the availability and access of data by appropriate users within fiscal constraints. The HRP complies with NPR 7100.1, Protection of Human Research Subjects, which is implemented at JSC via JPD 1382.5, Maintaining the Privacy of Biomedical Research Data. Its purpose is to establish a policy for protecting the privacy of data collected during voluntary medical research involving active, inactive, or retired spaceflight crewmembers and for ground-based and in-flight data collection. No data attributable to an individual will be publicly released without the permission of the subject. This concept encompasses non-disclosure of an individual's name and requires sufficient pooling of data to preclude determining an individual's identity by combining or cross-referencing data (e.g., height, weight, sex, and flight number may identify a specific individual).

The Life Sciences Data Archive (LSDA) contains research descriptions, publication citations, results, and data generated from NASA-sponsored spaceflight, flight analog, and ground investigations. JSC Institutional Review Board (IRB) has established a repository function for LSDA, which allows dissemination of this data for purposes beyond its original collection. Data management and distribution capabilities are available within the LSDA system and may be used to collect structured data for experiments, distribute that data, and archive experiment data for future use.

Astronaut data collected for clinical purposes are available for research through NASA's medical data repository, the Lifetime Surveillance of Astronaut Health (LSAH).

A request for research and/or clinical data must be submitted via the Data Request tab on the LSDA home page located at http://lsda.jsc.nasa.gov/. The request is reviewed by the Evidence Base Working Group, which may approve the request, identify additional information needed, or elevate the request to the LSAH Policy Board for additional discussion. The Board may approve requests, disapprove, or approve with conditions. Requestors will be contacted by a POC from the Working Group who will keep the requestor apprised of the status of their request.

HRP documents also include published journal articles, conference papers, and/or technical presentations generated by extramural and/or intramural researchers. HRP deliverables are archived using approved database applications.

3.7 SAFETY AND MISSION ASSURANCE

3.7.1 Research S&MA

3.7.1.1 Human Test Subjects

For NASA-funded investigations involving human subjects, the Element will comply with NPD 7100.8E and NPR 7100.1, Protection of Human Research Subjects, to ensure the health, safety, and privacy of the subjects are protected. All human research funded, sponsored, conducted, or supported by NASA, is reviewed by an Institutional Review Board (IRB) approved by NASA or the Office of Human Research Protection at the Department of Health and Human Services. IRBs are established at NASA Centers to review all ground-based and aeronautical flight research involving human subjects conducted at the centers or utilizing center equipment or personnel.

All research performed on NASA spacecraft involving crewmembers is reviewed by the JSC IRB. The HRP requires all HRP research to be reviewed by the IRB. The IRB has the authority to approve, disapprove, or require changes in the proposed human research protocols and procedures and to suspend or terminate its approval of research activities that are not conducted in accordance with the approved protocol or that have been associated with serious harm to subjects. For international projects, Element strategies will be submitted for additional review by the Human Research Multilateral Review Board.

3.7.1.2 Animal Test Subjects

For tasks involving animal subjects, the Element will obtain prior approval from the Institutional Animal Care and Use Committee for the appropriate testing location and will comply with the *NRC Guide for the Care and Use of Laboratory Animals* and the *Animal Welfare Act* (Code Fed. Reg. Title 9), and NPD 8910.1B and NPR 8910.1A, Care and Use of Animals.

3.7.1.3 Ground Research

Ground-based research will be conducted at multiple NASA Centers and non-NASA facilities. The HRP will comply with the approved safety, environmental, and quality standards for the performing center and facility.

3.7.1.4 Flight Research

For flight research, the Element will comply with the applicable standards and procedures governing flight payloads including SSP 50021, Safety Requirements Document. The ISSMP Project Manager and the funding Element Manager will ensure that S&MA processes are properly established and implemented within the task.

Hardware will be presented to the JSC Payload Safety Review Panel (PSRP). Safety engineers participate in all phases of the hardware and software design process and develop Phase 0, I, II,

and III Flight and Phase 0/I/II and III Ground Safety Data Packages for hardware items and act as a liaisons to the PSRP. Safety engineers review flight and ground procedures for compliance with safety requirements and identify hazard controls during the procedure development process prior to baseline. Compliance will be verified during the safety reviews as well as the Certification of Flight Readiness (CoFR) review process.

3.7.2 Technology Development

Technology development projects will comply with S&MA requirements at the relevant centers.

3.7.3 Mishap Preparedness and Contingency Plan Process

The PIO develops plans to be used by the HRP in the event of a contingency that falls under its jurisdiction. HRP-48000, Human Research Program Mishap Preparedness and Contingency Plan, defines appropriate responsibilities imposed on HRP organizations to comply with NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating and Recordkeeping. The HRP responsibility continues until the investigation's correction action plan is implemented. HRP-48000 applies to all HRP sponsored or funded ground and flight R&T development activities, whether those activities take place on-orbit at the International Space Station (ISS), at NASA Field Centers, at universities and non-profit research institutes, or at for-profit industries, and may involve human research subjects.

3.8 RISK MANAGEMENT STRATEGY

The HRP Program Manager implements a risk-informed decision making (RIDM) process, which feeds risks directly into the continuous risk management (CRM) process in accordance with NPR 8000.4, Risk Management Procedural Requirements. Appendix E, Program Risk Management Plan, contains further details of the programmatic risk management process.

The HRP uses the JSC Integrated Risk Management Application (JSC IRMA) as the common tool for documenting and tracking all programmatic risks. All ISS-unique risks are entered into the ISS IRMA. HRP risks which are related to ISS-unique risks are associated in IRMA.

3.9 ENVIRONMENTAL IMPACT

The HRP will comply with the responsibilities defined in NPD 8500.1B, NASA Environmental Management. The HRP requires each Element to evaluate the environmental risks and liabilities associated with each task. The Element or Project Manager is responsible for compliance with environmental requirements and development of documentation associated with environmental compliance considerations, as needed.

3.10 INSTITUTIONAL AND LOGISTICS

Institutional facilities and equipment exist at various NASA Centers to support HRP tasks, including ARC, GRC, JSC, and KSC.

External to NASA, the NSBRI consortium consisting of twelve member institutions provides facilities and equipment to support R&T development aimed at preventing or addressing health problems related to long-duration space travel and prolonged exposure to microgravity.

In addition, the HRP utilizes bed rest facilities at the University of Texas Medical Branch in Galveston, Texas, and has access to similar facilities in Europe through partnering agreements with international agencies. The program will utilize parabolic aircraft as needed to support its research projects.

The HRP makes use of the NASA Space Radiation Laboratory (NSRL) at the U.S. DoE Brookhaven National Laboratory, as well as other DoE laboratories and international laboratories. The HRP also utilizes radiation research facilities at the Loma Linda University Medical Center.

3.11 PHYSICAL AND INFORMATION TECHNOLOGY SECURITY

To ensure export controlled data, human subject privacy data, and NASA internal data are protected appropriately, the HRP manages its information in accordance with NASA information technology security policy, including export control per NPR 2190.1, NASA Export Control Program, and information security per NPR 2810.1, Security of Information Technology.

3.12 VERIFICATION AND VALIDATION

As an applied research program, the HRP will ensure verification and validation of all HRP R&T development deliverables, such as standards updates, new technologies, countermeasures, design models, and risk projection models. Verification and validation of HRP products will be completed prior to delivery.

The Elements will subject hardware and software used in flight experiments and tests to functional verification and safety reviews as required by the appropriate U.S. and International vehicle programs. The Elements will document these requirements in associated plans as required by these programs.

Validation of research tasks includes scientific merit review. Therefore, where possible, results from the research used in developing a deliverable will be published in peer-reviewed journals, using the appropriate refereed journal publication processes. Deliverables developed from the integration or research results will be validated through merit review and verified, where applicable, through independent procedure, hardware, or software verification processes.

The verification and validation of HRP deliverables are Element unique and will be documented in their management plans. Verification and validation are driven by the customer or stakeholder requirements and will be identified in associated CSAs.

3.13 REVIEWS AND KEY DECISION POINTS

3.13.1 Program Reviews and Reporting

The HRP will conduct management and technical reviews to maintain cognizance of current status and risks and to discuss progress toward accomplishment of goals and objectives for the program. The HRP will provide monthly, quarterly, and annual reports and status briefings to HEOMD as listed in Table 3-1 to keep the directorate apprised of current status, cost, schedule, and risks.

As an R&T Program under NPR 7120.8, Program Status Reviews (PSRs) will be conducted in accordance with NPR 7120.8 and every two years, unless waived by the APMC. This independent assessment is coordinated and led by the IPAO. Results are briefed to the HEOMD DPMC and the APMC.

Quarterly technical, cost, schedule, and risk reviews of each multi-center program Element, and applicable projects, are conducted at the program level with representation from each participating Center. The Element or project obtains status from the Centers and NSBRI and presents an integrated status of the R&T development tasks across the Element or project. In addition, HRP management and the Center POCs have a separate session during the review to address center-specific issues. The key metric in the quarterly timeframe is how well the planned activities adhere to schedules and whether or not expected results were achieved.

3.13.2 Research Reviews

The quality of basic and applied research efforts within the HRP is assured by competition and merit review, where merit review means independent evaluation by internal or external subject matter experts who do not have a conflict of interest. For all investigations/tasks (science and technology) funded by the HRP, merit reviews are conducted in accordance with the HRP Science Management Plan (HRP-47053, Rev D), which implements NPR 1080.1A, Requirements for the Conduct of NASA Research and Technology (R&T). The merit review determines the quality, relevance, and value of the work.

3.13.3 Other Reviews

The HRP Program Manager will recommend use of advisory boards when external advice is required. Any advisory board usage will be approved and managed by the HEOMD. Examples of advisory boards relevant to the HRP include the National Research Council (NRC), National Academy of Sciences (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM). Elements and projects will use focused advisory boards or working groups when external advice specific to Element or project objectives are required.

The HRP Elements and projects will support CoFR Reviews per JSC 28225, CoFR Implementation Plan, for missions involving HRP research objectives or flight experiments. This document addresses specific reporting to the vehicle programs, such as SSP 52054, ISS Program Payloads CoFR Implementation Plan, Generic.

The HRP supports independent assessments, external audits, and other program evaluations as required by NPR 7120.8.

Table 3-1: HRP Program Reporting and Reviews

Review / Report	Frequency	Customer Organization	Input Responsibility
HEOMD Level			
HRP Monthly Activity Report (MAR)	Monthly	HEOMD	HRP Program Office
HRP Quarterly Review	Quarterly	HEOMD	HRP Program Office
HRP Annual Report	Annual	HEOMD	HRP Program Office
Planning, Programming, Budgeting, and Execution (PPBE)	Annual	HEOMD/HRP	Elements and Projects
Program Status Review (PSR)	Every two years after PIR	APMC/HEOMD designated independent review team	HRP Program Office and IPAO
Cancellation Reviews	As required	HEOMD/HRP	Elements and Projects
Program Level			
HRP Quarterly Review (TCSR)	Quarterly	HRP Program Office	Elements and Projects
HRP Programmatic Risk Review	Quarterly	HRP Program Office	Elements, Projects, HRP Risk Manager
Certification of Flight Readiness (CoFR) Review	Prior to related launch	Flight Vehicle Program Office	JSC/HHPD and Elements and Projects

3.14 EDUCATION AND PUBLIC OUTREACH

The HRP Education and Outreach (HRPEO) office provides educational and general information to students, educators, and the general community to help clearly communicate the full scope of NASA HRP research. The target audience ranges from K-12 and higher education to professional and life-long learning. The focus of this material is to communicate relevant aspects of the HRP to the community and to help stimulate students to further their education in math, science, engineering and related technology fields. HRPEO office maintains the HRP Strategic Communication Plan and the baseline HRPEO budget and schedule, integrated with the PSM budget and schedule. The HRPEO office leads budget formulation and integration of the HRPEO office budget and supports integration with PSM input for the annual PPBE process.

3.15 TERMINATION REVIEW CRITERIA

The HRP will review the status of each Element and project annually and assess the ability to meet its objectives. HRP Elements and projects are subject to termination as authorized by the

HRP Program Manager. Criteria for termination includes:

- Strategic: inconsistent with the exploration vision; inconsistent with the program/mission objectives; overlap with another funded activity; or low priority ranking for the HRP given funding constraints;
- Technical/Scientific: performance measures indicate that the technology will not achieve the required technical results by the scheduled need date; performance measures indicate degradation in projected performance versus performance commitments; product delivered is of insufficient quality and/or does not meet performance requirements;
- Cost: over budget by five percent per year for an Element; over budget by fifteen percent per year for a project;
- Schedule: missed milestone(s) or key decision points; missed due dates for major activities, projected delay in the operational readiness review greater than 6 months from the committed date;
- Noncompliance with Agency or HEOMD policy;
- Knowledge sought is obtained through means other than the current HRP-funded activities.

3.16 WAIVERS

There are no known deviations or waivers against NASA policies, directives or external requirements, either in existence within the HRP or to be obtained by the HRP.

APPENDIX A: APPLICABLE DOCUMENTS

The following documents of the specified revision or the latest revision if not identified, form a part of this plan to the extent defined herein.

Document No.	Revision	Document Title
Code Fed. Reg. Title 9	January 1, 2009	Animal Welfare Act
	July 2012	HRP Program Commitment Agreement, Rev B
HRP-47052, Rev F	February 2013	HRP Program Requirements Document (PRD)
HRP-47053, Rev D	May 12, 2011	HRP Science Management Plan
HRP-47054, Rev C	May 2012	HRP Documentation Tree
HRP-47065, Rev D	July 2012	HRP Integrated Research Plan (IRP)
HRP-47069, Rev C, PCN 2	October 31, 2012	HRP Unique Processes, Criteria, and Guidelines (UPCG)
HRP-47081	August 12, 2010	HRP Strategic Communication Plan
JSC 28225, Rev G	November 4, 2012	Certification of Flight Readiness (CoFR) Implementation Plan
JSC 28330, Rev E	November 2010	Space and Life Sciences Directorate Configuration Control Management Plan
NASA/SP-2004-6113	February 2005	Bioastronautics Roadmap
NASA-STD-3001	September 25, 2009	NASA Space Flight Human System Standard - Volume 1: Crew Health
NASA-STD-3001	January 1, 2011	NASA Space Flight Human System Standard - Volume 2: Human Factors, Habitability, and Environmental Health
NASA-STD-7009	July 11, 2008	Standards for Models and Simulations
NPD 1000.0A	August 13, 2008	NASA Strategic Management and Governance Handbook
NPD 1000.5B	December 19, 2013	Policy for NASA Acquisition
NPD 1001.0A	February 14, 2011	2011 NASA Strategic Plan

Document No.	Revision	Document Title
NPD 2190.1B	December 27, 2011	NASA Export Control Program
NPD 2810.1D	May 9, 2009	NASA Information Security Policy
NPD 7100.8E	May 31, 2002	Protection of Human Research Subjects (Revalidated with admin. changes June 14, 2007)
NPD 8500.1B	December 20, 2007	NASA Environmental Management
NPD 8700.1E	October 28, 2008	NASA Policy for Safety and Mission Success
NPD 8910.1B	May 28, 2008	Care and Use of Animals
NPR 1080.1A	May 30, 2008	Requirements for the Conduct of NASA Research and Technology (R&T)
NPR 2190.1B	June 20, 2012	NASA Export Control Program
NPR 2800.2	January 6, 2011	Electronic and Information Technology Accessibility
NPR 2810.1A	May 16, 2006	Security of Information Technology (Revalidated with Change 1, May 19, 2011
NPR 5800.1E	October 19, 2000	NASA Grant and Cooperative Agreement Handbook (14 CFR 1260) (Revalidated March 10, 2011)
NPR 7100.1	March 28, 2003	Protection of Human Research Subjects
NPR 7120.5E	August 14, 2012	NASA Space Flight Program and Project Management Requirements
NPR 7120.8	February 5, 2008	NASA Research and Technology Program and Project Management Requirements
NPR 7150.2A	November 19, 2009	NASA Software Engineering Requirements
NPR 8000.4A	December 16, 2008	Agency Risk Management Procedural Requirements
NPR 8900.1A	July 17, 2012	Health and Medical Requirements for Human Space Exploration
NPR 8910.1C	December 2, 2011	Care and Use of Animals
NSTS 1700.7B ISS Addendum	December 1995	Safety Policy and Requirements for Payloads Using the International Space Station
SSP 50021, Rev B	February 2000	Safety Review Process, International Space Station

APPENDIX B: ACRONYMS AND ABBREVIATIONS

AA Associate Administrator

ACSM American College of Sports Medicine

AEH Advanced Environmental Health

AFAR American Federation for Aging Research

AFT Advanced Food Technology

ANITA Analyzing Interferometer for Ambient Air

AO Announcement of Opportunity

APMC Agency Program Management Council

ARC Ames Research Center

ARED Advanced Resistive Exercise Device

ARGOS Active Response Gravity Offload System

ARM Active Risk Manager

ATV Automated Transfer Vehicle

BAA Broad Agency Announcement

BEO Beyond Earth Orbit

BHP Behavioral Health and Performance

BNL Brookhaven National Laboratory

BR Bioastronautics Roadmap

CA Cooperative Agreement

CAN Cooperative Agreement Notice

CARR Center for Acute Radiation Research

CCB Configuration Control Board

CDC Centers for Disease Control

CHMO Chief Health and Medical Officer

CHOICE Consequences of Long-Term Confinement and Hypobaric Hypoxia on Immunity in the Antarctic Concordia Environment

CM Countermeasure

CMO Chief Medical Officer

CNES Centre National d'Etudes Spatiales (French Space Agency)

CNS Central Nervous System

CoFR Certification of Flight Readiness

CRL Countermeasure Readiness Level

CRM Continuous Risk Management

CSA Customer-Supplier Agreement

CSA Canadian Space Agency

DCS Decompression Sickness

DFRC Dryden Flight Research Center

DLR German Aerospace Center

DOD Department of Defense

DOE Department of Energy

DPMC HEOMD Program Management Council

ESMD Exploration Systems Mission Directorate

EBIS Electron Beam Ion Source

EDC Earth Resources Observation Systems (EROS) Data Center

EFT Exploration Flight Test

EKE Kinetics during Physical Training

EM Exploration Mission

EPM European Physiology Modules

ESA European Space Agency

EVA Extravehicular Activity

ExMC Exploration Medical Capability

fMRI Functional Magnetic Resonance Imaging (MRI)

FY Fiscal Year

GPRA Government Performance and Results Act

GRC Glenn Research Center

HEOMD Human Exploration and Operations Mission Directorate (HQ)

HHC Human Health Countermeasures

HHPD Human Health and Performance Directorate

HMTA Health and Medical Technical Authority

HQ Headquarters (NASA)

HRMRB Human Research Multilateral Review Board

HRP Human Research Program

HRR Human Research Roadmap

HRPCB HRP Control Board

HRPEO HRP Education and Outreach Office

HSRB Human System Risk Board

HSRT Human Systems Research and Technology

HTV H-II Transfer Vehicle

HZETRN High charge (Z) and Energy TRaNsport

IBMP Institute of Biomedical Problems

IEWG ISS Expert Working Group

IMS Integrated Master Schedule

IRP Integrated Research Plan

IOM Institute of Medicine

IPAO Independent Program Assessment Office

IRB Institutional Review Board

IRMA Integrated Risk Management Application

ISLSWG International Space Life Sciences Working Group

ISO International Science Office

ISS International Space Station

ISSMP ISS Medical Projects

IVD Intervertebral Disk Damage

JAXA Japan Aerospace Exploration Agency

JSC Johnson Space Center

KSC Kennedy Space Center

LADTAG Lunar Airborne Dust Toxicity Advisory Group

LaRC Langley Research Center

LBNL Lawrence Berkeley National Laboratory

LEUKIN EXPERIMENT: Role of interleukin-2 receptor in signal transduction and gravisensing threshold of T-lymphocytes

LLU Loma Linda University

LSAH Lifetime Surveillance of Astronaut Health

LSDA Life Sciences Data Archive

M, L & T Muscle, Ligament and Tendon

MAR Monthly Activity Report

MARES Muscle Atrophy Research and Exercise System

MMOP Multilateral Medical Operations Panel

MOA Memorandum (Memoranda) of Agreement

MLS Major League Soccer

MPCV Multi-Purpose Crew Vehicle

MSFC Marshall Space Flight Center

NAE National Academy of Engineering

NAR Non-Advocate Review

NAS National Academy of Sciences

NASA National Aeronautics and Space Administration

NASDA National Space Development Agency (of Japan)

NCI National Cancer Institute

NCM Nutritional Countermeasure

NCRR National Center for Research Resources

NHLBI National Heart, Lung, and Blood Institute

NIAMS National Institute of Arthritis and Musculoskeletal and Skin

NIDCD National Institute on Deafness and Other Communication Disorders

NIH National Institute of Health

NINDS National Institute of Neurological Disorders and Stroke

NLM National Library of Medicine

NOAA National Oceanic and Atmospheric Administration

NPD NASA Policy Directive

NPR NASA Procedural Requirements

NRA NASA Research Announcement

NRC National Research Council

NSBRI National Space Biomedical Research Institute

NSF National Science Foundation

NSRL National Space Radiation Laboratory

OBER Office of Biological and Environmental Research

OCE Office of the Chief Engineer

OCHMO Office of the Chief Health and Medical Officer (HQ)

OCT Office of Chief Technologist

OGP Office of Global Programs

OOAR Office of Oceanic and Atmospheric Research

OSMA Office of Safety and Mission Assurance

PART Program Assessment and Rating Tool

PCA Program Commitment Agreement

PCPFS President's Council on Physical Fitness and Sports

PEL Permissible Exposure Limit

PFS Pulmonary Function System

PIO Program Integration Office

PIR Program Implementation Review

PKINASE Protein Kinase C Isoform Translocation in Monocytes Exposed to Microgravity

PMC Program Management Council

POC Point of Contact

Pogo Partial Gravity Simulator

PPBE Planning, Programming, Budgeting, and Execution

PPFS Portable Pulmonary Function Systems

PRD Program Requirements Document
PSM Program Science Management

PSR Program Status Review

PSRP Payload Safety Review Panel

R&T Research and Technology

RAS Russian Academy of Science

RFP Request for Proposal

RIDM Risk-Informed Decision Making

RMAT Risk Management Analysis Tool

S&MA Safety and Mission Assurance

SBIR Small Business Innovation Research

sDTOCMS Supplemental Detailed Test Objective Countermeasure System

SHFE Space Human Factors Engineering

SHFH Space Human Factors and Habitability

SLSD Space Life Sciences Directorate (JSC)

SM Space Medicine Division (HHPD)

SMO Science Management Office

SMP Science Management Panel (HRP SMO)

SOPD Strategic Opportunities and Partnership Development

SPRINT Integrated Resistance and Aerobic Training Study

STEM Science, Technology, Engineering, and Mathematics

SR Space Radiation

TCSR Technical, Cost, and Schedule Review

TEPC Tissue Equivalent Proportional Counter

TRL Technology Readiness Level

UPCG Unique Process, Criteria, and Guidelines

USA United States of America

USAF United States Air Force

USDA United States Department of Agriculture

USGS United States Geological Survey

USUHS Uniformed Services University of the Health Sciences

UTMB University of Texas Medical Branch

VIIP Visual Impairment/Intercranial Pressure

WBS Work Breakdown Structure

ZAG Z-Aligned Gravitoinertial

ZBR Zero-Base Review

ZLS Zero-gravity Locomotion Simulator

APPENDIX C: PROGRAM WORK BREAKDOWN STRUCTURE

Level	New WBS Code	WBS NAME
1	046193	Program Science Management/NSBRI
2	046193.01	Portfolio Management
3	046193.01.01	ARC-PSM Portfolio Management
4	046193.01.01.10	ARC-PSM CS Labor and Travel - Direct Mgmt
4	046193.01.01.12	ARC-PSM Project Integration and Support
4	046193.01.01.13	ARC-PSM Conferences, Workshops and Meetings
4	046193.01.01.14	ARC-PSM Institutional I/T (ACES seats)
4	046193.01.01.15	ARC-PSM Non-seat I/T
4	046193.01.01.16	ARC-PSM Equipment and Calibration Svcs
4	046193.01.01.17	ARC-PSM Organization Taxes
4	046193.01.01.90	ARC-Program Travel Reallocation
4	046193.01.02.10	GRC CS Labor & Travel direct management
4	046193.01.02.90	GRC-Program Travel Reallocation
4	046193.01.04.10	JSC-PSM JSC CS Labor and Travel-Direct
4	046193.01.04.11	JSC-PSM JSC Indirect Labor & Travel
4	046193.01.04.12	JSC-PSM Project Integration and Support
4	046193.01.04.13	JSC-HRP Workshops
4	046193.01.04.14	JSC-Institutional I/T
4	046193.01.04.15	JSC-Non-Institutional I/T
4	046193.01.04.17	JSC-PSM Organization Taxes
4	046193.01.04.18	JSC-Element Reserve
4	046193.01.04.19	JSC-Education & Outreach
4	046193.01.04.90	JSC-Program Travel Reallocation
4	046193.01.06.90	MSFC-Program Travel Reallocation
4	046193.01.07.90	LaRC-Program Travel Reallocation
3	046193.01.07	LaRC-Portfolio Management
4	046193.01.07.12	LaRC-Project Integration & Support
2	046193.02	Funded Research/Awards
3	046193.02.01	ARC-Funded Research/Awards
4	046193.02.01.03	ARC-NSBRI Awards
4	046193.02.01.10	ARC-PSM CS Labor and Travel - Direct Research

4	046193.02.02.03	GRC-NSBRI Cooperative Agreement
4	046193.02.02.10	GRC CS Labor & Travel direct research
3	046193.02.03	NASA Research & Education Support Services (NRESS)-Task book
4	046193.02.04.03	JSC-NSBRI Cooperative Agreement
4	046193.02.06.03	MSFC-ExMC NSBRI NASA PI/Co-1
4	046193.02.07.10	LaRC- CS Labor & Travel - Direct Research
4	046193.03.04.01	JSC -Analog Fees
4	046193.03.04.10	JSC-PSM Labor &Travel Direct Operations
1	444543	Exploration Medical Capabilities
2	444543.01	Portfolio Management
3	444543.01.01	ARC-Portfolio Management
4	444543.01.01.17	ARC Organization Taxes
4	444543.01.01.90	ARC-Program Travel Reallocation
4	444543.01.02.90	GRC-Program Travel Reallocation
4	444543.01.04.90	JSC-Program Travel Reallocation
4	444543.01.07.90	LaRC-Program Travel Reallocation
3	444543.01.02	GRC-Portfolio Management
4	444543.01.02.12	GRC-Project Integration and Support
3	444543.01.04	JSC-Portfolio Management
4	444543.01.04.10	JSC-CS Labor and Travel -Direct Management
4	444543.01.04.12	JSC-Project Integration & Support
4	444543.01.04.14	JSC-Institutional I/T (ACES Seats)
4	444543.01.04.15	JSC-Non-Seat IT
4	444543.01.04.16	JSC-Equipment Calibration Services (BOR)
4	444543.01.04.17	JSC-ExMC Organization Taxes
4	444543.01.04.18	JSC-ExMC Reserves
3	444543.01.07	LaRC-Portfolio Management
4	444543.01.07.14	LaRC-Institutional I/T (ACES)
4	444543.01.07.17	LaRC-Organization Taxes
2	444543.02	Funded Research/Awards
3	444543.02.01	ARC-Funded Research/Awards
4	444543.02.01.04	ARC-ExMC Medical Technologies Dev't
4	444543.02.01.06	ARC-ExMC Tech Watch
4	444543.02.01.10	ARC-ExMC CS Labor and Travel-Direct Research
3	444543.02.02	GRC-Funded Research/Awards
4	444543.02.02.04	GRC-ExMC Medical Technologies Dev't

4	444543.02.02.05	GRC-ExMC Medical Informatics and Science Integration
4	444543.02.02.06	GRC-ExMC Tech Watch
4	444543.02.02.10	GRC-CS Labor and Travel-Direct Research
3	444543.02.04	JSC-Funded Research/Awards
4	444543.02.04.04	JSC-ExMC Medical Technologies Dev't
4	444543.02.04.05	JSC-ExMC Medical Informatics and Science Integration
4	444543.02.04.06	JSC-ExMC Tech Watch
3	444543.02.07	LaRC-Funded Research/Awards
4	444543.02.07.06	LaRC-ExMC Tech Watch
4	444543.02.07.10	LaRC-CS Labor & Travel - direct research
1	466199	Space Human Factors Engineering (SHFE)
2	466199.01	Portfolio Management
3	466199.01.01	ARC-Portfolio Management
4	466199.01.01.10	ARC-CS Labor and Travel-direct management
4	466199.01.01.11	ARC-CS Labor and Travel-indirect
4	466199.01.01.12	ARC-Project Integration & Support
4	466199.01.01.90	ARC-Program Travel Reallocation
4	466199.01.04.90	JSC-Program Travel Reallocation
3	466199.01.04	JSC-Portfolio Management
4	466199.01.04.10	JSC-CS Labor and Travel-direct management
4	466199.01.04.11	JSC-CS Labor and Travel-indirect
4	466199.01.04.12	JSC-Project Integration and Support
4	466199.01.04.14	JSC-Institutional IT (ACES)
4	466199.01.04.16	JSC-Equipment and Calibration Services
4	466199.01.04.18	JSC-MGMT Reserves
2	466199.02	Funded Research/Awards
3	466199.02.01	ARC-Funded Research/Awards
4	466199.02.01.03	ARC-SHFE
4	466199.02.01.05	ARC-AEH Projects
4	466199.02.01.10	ARC-CS Labor and Travel-direct research
3	466199.02.04	JSC-Funded Research/Awards
4	466199.02.04.03	JSC-SHFE
4	466199.02.04.04	JSC-Advanced Food
4	466199.02.04.05	JSC-Advanced Environmental Health
4	466199.02.04.10	JSC-CS Labor and Travel-direct research
4	466199.03.01.10	ARC-CS Labor and Travel- direct operations

4	466199.03.04.10	JSC-CS Labor and Travel- direct operations
1	516724	Human Health Countermeasures (HHC)
2	516724.01	Portfolio Mgmt
3	516724.01.01	ARC PORTFOLIO MANAGEMENT
4	516724.01.01.10	ARC-CS Labor & Travel - Direct Management
4	516724.01.01.12	ARC-PROJECT INTEGRATION & SUPPORT
4	516724.01.01.14	ARC-INSTITUTIONAL I/T
4	516724.01.01.15	ARC-NON-SEAT I/T
4	516724.01.01.16	ARC-EQUIPMENT AND CALIBRATION SERVICES
4	516724.01.01.17	ARC-ORGANIZATION TAXES
4	516724.01.01.18	ARC-ELEMENT RESERVES
4	516724.01.01.19	ARC-EDUCATION & OUTREACH
4	516724.01.01.90	ARC-Program Travel Reallocation
3	516724.01.02	GRC-PORTFOLIO MANAGEMENT
4	516724.01.02.10	GRC-CS Labor & Travel - Direct Management
4	516724.01.02.12	GRC-PROJECT INTEGRATION & SUPPORT
4	516724.01.02.14	GRC-INSTITUTIONAL I/T
4	516724.01.02.15	GRC-NON-SEAT I/T
4	516724.01.02.16	GRC-EQUIPMENT AND CALIBRATION SERVICES
4	516724.01.02.17	GRC-ORGANIZATION TAXES
4	516724.01.02.90	GRC-Program Travel Reallocation
3	516724.01.04	JSC PORTFOLIO MANAGEMENT
4	516724.01.04.10	JSC-CS Labor & Travel - Direct Management
4	516724.01.04.11	JSC-CS Labor & Travel - Indirect
4	516724.01.04.12	JSC-Project Integration & Support
4	516724.01.04.14	JSC-INSTITUTIONAL I/T (ACES Seats)
4	516724.01.04.15	JSC-NON-SEAT I/T (SR Purchases)
4	516724.01.04.16	JSC-EQUIPMENT AND CALIBRATION SERVICES
4	516724.01.04.17	JSC-ORGANIZATION TAXES
4	516724.01.04.18	JSC-ELEMENT RESERVES
4	516724.01.04.19	JSC-EDUCATION & OUTREACH
4	516724.01.04.90	JSC-Program Travel Reallocation
2	516724.02	Funded Res/Awards
3	516724.02.01	ARC FUNDED RESEARCH/AWARDS
4	516724.02.01.10	ARC-HHC Labor and Travel (Direct)
4	516724.02.01.20	ARC-Research Wedge

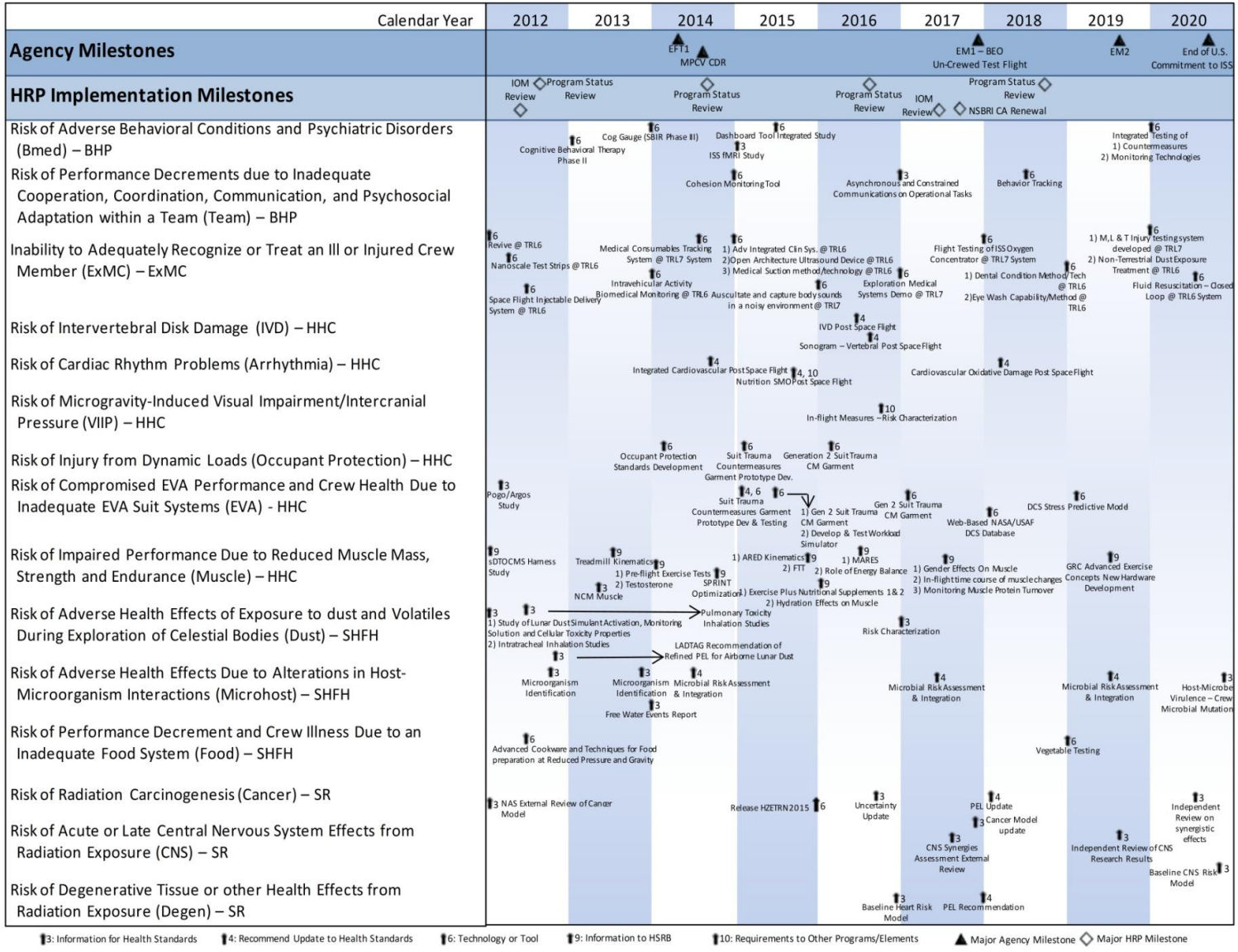
4	516724.02.01.21	ARC Research
3	516724.02.02	GRC FUNDED RESEARCH/AWARDS
4	516724.02.02.10	GRC-CS Labor & Travel - Direct Research
4	516724.02.02.20	GRC-Research Wedge
4	516724.02.02.21	GRC RESEARCH
3	516724.02.04	JSC FUNDED RESEARCH/AWARDS
4	516724.02.04.10	JSC-Labor & Travel-Direct Research
4	516724.02.04.20	JSC-Research Wedge
4	516724.02.04.21	JSC-Vision & Cardio Portfolio
4	516724.02.04.22	JSC-Exercise & Performance Portfolio
4	516724.02.04.23	JSC-Multi-system Portfolio
4	516724.02.04.24	JSC-Bone Portfolio
4	516724.02.04.25	JSC-TECHNOLOGY/INFRASTRUCTURE PORTFOLIO
2	516724.03	Facilities, Testbeds & Operations
3	516724.03.01	ARC FAC/TESTBEDS/OPS
3	516724.03.02	GRC FAC/TESTBEDS/OPS
4	516724.03.02.01	Exercise - GRC eZLS Sustaining Engineering
3	516724.03.04	JSC FAC/TESTBEDS/OPS
4	516724.03.04.10	TEST SUBJECT SCREENING (TSS)
4	516724.03.04.11	SAMPLE ARCHIVE (CONROE)
1	651549	Space Radiation
2	651549.01	Portfolio Management
3	651549.01.01	ARC-Portfolio Management
4	651549.01.01.10	ARC-SRPE CS Labor and Travel - Direct Mgmt
4	651549.01.01.12	ARC-SRPE Project Integration and Support
4	651549.01.01.14	ARC-SRPE Institutional I/T (ACES seats)
4	651549.01.01.15	ARC-SRPE Non-seat I/T
4	651549.01.01.16	ARC-SRPE Equipment and Calibration Svcs
4	651549.01.01.17	ARC-SRPE Organization Taxes
4	651549.01.01.90	ARC-Program Travel Reallocation
3	651549.01.04	JSC-Portfolio Management
4	651549.01.04.10	JSC -CS Labor & Travel - Direct Management
4	651549.01.04.11	JSC -CS Labor & Travel - Indirect
4	651549.01.04.12	JSC-Project Integration and Support
4	651549.01.04.13	JSC-Conferences, Workshops and Meetings
4	651549.01.04.18	JSC Reserve

4	651549.01.04.19	JSC- Education & Outreach
4	651549.01.04.90	JSC-Program Travel Reallocation
3	651549.01.07	LaRC-Portfolio Management
4	651549.01.07.10	LaRC-CS Labor & Travel - direct mgt
4	651549.01.07.12	LaRC-Project Integration & Support
4	651549.01.07.13	LaRC-Conferences,Workshops,& Meetings
4	651549.01.07.14	LaRC-Institutional I/T (ACES)
4	651549.01.07.17	LaRC-Organization Taxes
4	651549.01.07.18	LaRC-Element Reserves
4	651549.01.07.90	LaRC-Program Travel Reallocation
2	651549.02	Funded Research/Awards
3	651549.02.01	ARC-Funded Research/Awards
4	651549.02.01.04	ARC-Biological Risk & Countermeasure
3	651549.02.04	JSC-Funded Research/Awards
4	651549.02.04.03	JSC Integrated Risk Assessment
4	651549.02.04.04	JSC-Biological Risk & Countermenasure FY12 & Prior
4	651549.02.04.09	JSC-Biological Risk & Countermenasure FY13 & Out
4	651549.02.04.10	JSC -CS Labor & Travel - Direct Research
4	651549.02.04.20	JSC-Research Wedge
3	651549.02.07	LaRC- Funded Research/Awards
4	651549.02.07.06	LaRC-SR Radiation Measurements & Trans Codes
4	651549.02.07.07	LaRC-SR Radiation Shielding Design Tools
4	651549.02.07.10	LaRC-CS Labor & Travel - direct research
2	651549.03	Facilities, Testbeds and Operations
3	651549.03.04	JSC-Facilities, Testbeds & Operations
4	651549.03.04.01	JSC-Brookhaven National Laboratory
1	868800	ISSMP
2	868800.01	ISSMP Portfolio Management
3	868800.01.01	ARC-Portfolio Management
4	868800.01.01.10	ARC-CS Labor and Travel - Direct Mgmt
4	868800.01.01.11	ARC -CS Labor & Travel - Indirect
4	868800.01.01.17	ARC-Organization Taxes
4	868800.01.01.90	ARC-Program Travel Reallocation
3	868800.01.04	JSC-Portfolio Management
4	868800.01.04.10	JSC -CS Labor & Travel - Direct Management
4	868800.01.04.11	JSC -CS Labor & Travel - Indirect

4	868800.01.04.12	JSC-Project Integration and Support
4	868800.01.04.13	JSC-Conferences, Workshop and meetings
4	868800.01.04.14	JSC-Institutional I/T
4	868800.01.04.15	JSC-Non-Seat I/T-Web Dev,Subscb Lics Etc
4	868800.01.04.16	JSC-Equipment and Calibration Services
4	868800.01.04.17	JSC-Organization Taxes (Indir.Proc.)
4	868800.01.04.18	JSC Reserve
4	868800.01.04.90	JSC-Program Travel Reallocation
3	868800.01.05	KSC-Portfolio Management
4	868800.01.05.10	KSC -CS Labor & Travel - Direct Management
4	868800.01.05.11	KSC -CS Labor & Travel - Indirect
4	868800.01.05.90	KSC-Program Travel Reallocation
2	868800.03	ISSMP Facilities, Testbeds & Operations
3	868800.03.01	ARC-Facilities, Testbeds, & Operations
4	868800.03.01.01	ARC-Flight Projects Management
4	868800.03.01.10	ARC- CS Labor and Travel - Operations
3	868800.03.04	JSC-Facilities, Testbeds, & Operations
4	868800.03.04.01	JSC-Flight Projects Management
4	868800.03.04.05	JSC-Flight Analog Project
3	868800.03.05	KSC-Facilities, Testbeds, & Operations
4	868800.03.05.01	KSC-Flight Projects Management
1	939924	Behavioral Health and Performance (BHP)
2	939924.01	Portfolio Management
3	939924.01.04	JSC-Portfolio Management
4	939924.01.04.10	JSC BHP Labor and Travel
4	939924.01.04.12	JSC-BHP Integr Spt
4	933924.01.04.13	JSC-BHP Annual Working Group
4	933924.01.04.15	JSC-Spaceline Support
4	933924.01.04.18	JSC-BHP Reserves
4	933924.01.04.19	JSC-Education &Outreach
4	933924.01.04.20	JSC-BHP Transition to Operations Consultant Fees
4	933924.01.04.90	JSC-Program Travel Reallocation
2	939924.02	Funded Research/Awards
3	939924.02.04	JSC-Funded Research/Awards
4	939924.02.04.21	JSC-BHP Team Project
4	939924.02.04.22	JSC-BHP Sleep Project

4	**939924.02.04.23**	**JSC-BHP B Med Project**

APPENDIX D: HRP KEY TARGET MILESTONES



APPENDIX E: PROGRAM RISK MANAGEMENT PLAN

E1. INTRODUCTION

E1.1 Purpose

The purpose of this plan is to document the process by which the Human Research Program (HRP) will identify, assess, control and respond to risk factors that occur in the program. It provides personnel across the Elements and projects with a description of how the HRP manages programmatic risks. This plan meets the intent of NPR 7120.8 and NPR 8000.4 for the HRP risk management process.

E1.2 Scope

The HRP defines and manages programmatic risks related to achieving its baseline schedule, budget, and deliverable products. This plan is applicable to the management offices (PIO and SMO), Elements, and projects that comprise the HRP, including associated contractor support.

Although the purpose of the HRP is to reduce human health and performance risks for exploration missions, the process for managing these risks is not addressed in this plan. The HRP Science Management Plan (HRP-47053, Rev D), governs this risk content and contains the policies utilized in the science management of the human health and performance risks.

This plan does not cover risks identified when performing tasks for external programs (i.e., Shuttle Program, ISS Program, CxP), such as trades, analyses, or other assessments. Risks identified as a consequence of those tasks are owned by the funding program. These risks are typically managed through the HSRB process.

E2. DOCUMENTS

E.2.1 Applicable Documents

JPR 8000.4	June 25, 2010	JSC Risk Management Plan
NPD 1000.5B	December 19, 2013	Policy for NASA Acquisition
NPR 7120.8	February 5, 2008	NASA Research and Technology Program and Project Management Requirements
NPR 8000.4A	December 16, 2008	Agency Risk Management Procedural Requirements

E3. RISK MANAGEMENT METHODOLOGY, PROCESS, AND TOOLS

E3.1 Risk-Informed Decision Making (RIDM) and Continuous Risk Management (CRM)

NPR 8000.4A requires the integration of RIDM and CRM into a coherent framework to better inform decision making through better use of risk information. HRP utilizes this construct wherein research and planning decisions are made with regard to outcomes of the decision alternatives, taking into account applicable risks and uncertainties. The HRP primarily uses

CRM to manage programmatic risks related to achievement of human performance requirements and safety for space operations.

The HRP implements the CRM process as described in NPR 8000.4A. The CRM process, shown in Figure E-1, is an iterative process based on six specific steps. The six CRM steps include: identify, analyze, plan, track, control, and communicate and document. The CRM principles are incorporated throughout the HRP management offices, Elements, and projects. The HRP CRM process flow is illustrated in Figure E-2 from the HRP Scorecard in the JSC Integrated Risk Management Application (IRMA).

Figure E-1: CRM Process

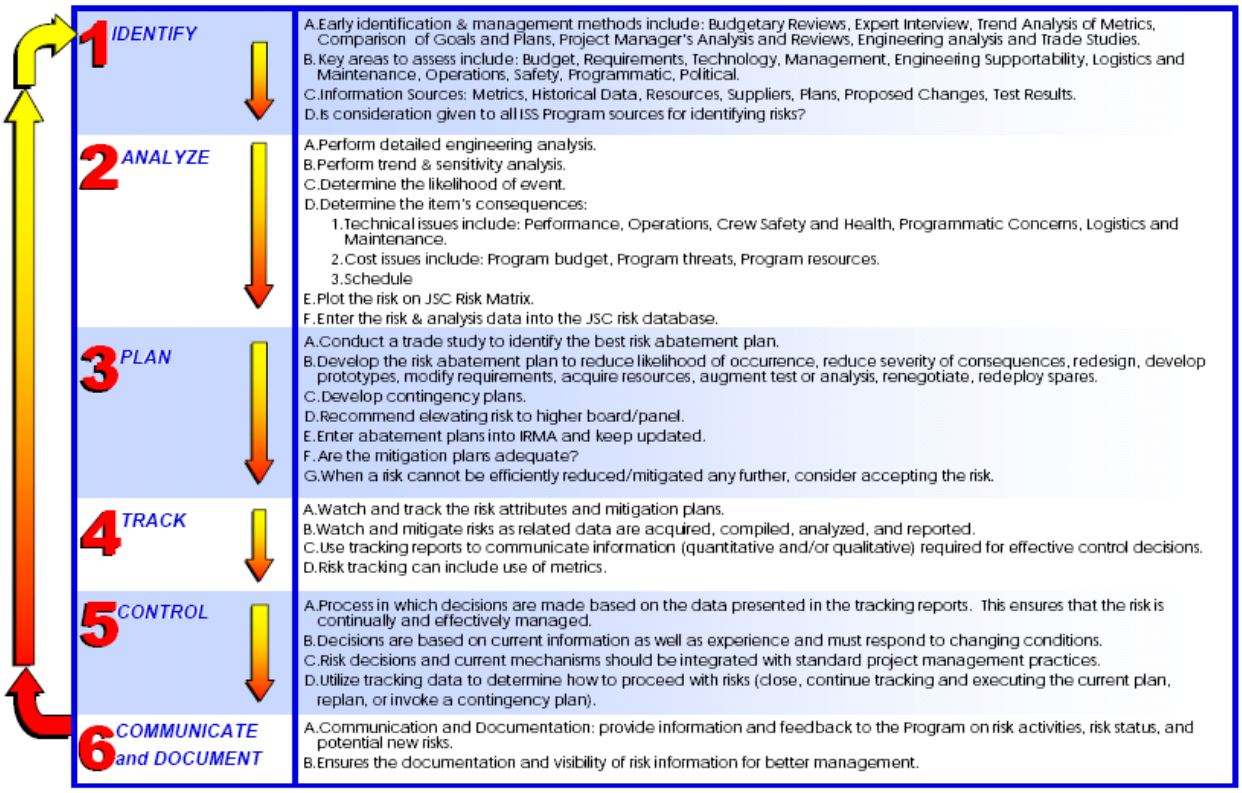


Figure E-2: CRM Process Flow

E3.2 HRP Risk Management Process

E3.2.1 Risk Identification

Programmatic risks are driven by technical risks, budget constraints, and schedule. Risks are identified during daily activities of personnel, close call reports, lessons learned, meeting proceedings, etc. Risk statements are written, citing only one risk condition, and one or more consequences of that condition. Circumstances, contributing factors and other related issues are captured. Good risk identification information provides the what, how, when, where, and why of the risk condition. Each risk has a responsible person assigned as owner.

E3.2.2 Risk Analysis

Each risk is evaluated as to the likelihood and the consequences of the risk. A scale of 1 to 5 is used, where one is the lowest likelihood/least consequence, and five is the highest likelihood/consequence. The risk consequence score is based on cost, schedule, safety, and technical (mission success) parameters. The likelihood and consequence matrices are shown in Tables E-1 and E-2. The impact of the risk is determined from a matrix of the likelihood crossed with the consequence of the risk, which is displayed using the 5 x 5 matrix method shown in Figure E-3.

Table E-1: Consequence Criteria Matrix for Assessment of HRP Risks

Classification		Consequence Criteria			
		Safety	**Schedule**	**Cost**	**Technical (Mission Success or Supportability)**
5	Very High	Condition may lead to death or permanent disabling injury, facility destruction, or loss of crew, major systems or vehicle	Slip in delivery to the flight program, slip in delivery of major system or subsystem beyond 6 months of milestone schedule	≥10% increase to HRP budget allocation	Loss of mission
4	High	Condition may cause severe injury or occupational illness, or major property damage to facilities, systems, equipment or flight hardware.	Delay of > 5 month ≤ 6 month for deliverables from milestone schedules	≥ 8% but < 10% increase to budget allocation	Loss of critical function or major science objective
3	Moderate	Condition may cause minor injury or occupational illness, or minor property damage to facilities, systems, equipment or flight hardware.	Delay of > 3 months < 5 months for deliverables from milestone schedules	>5% but <8% increase to budget allocation	Inability to meet power, weight, size and/or performance requirements; major science objectives not fully met
2	Low	Condition may result in minor first aid though would not adversely affect personal safety or health. Subjects facilities, equipment or flight hardware to more than normal wear and tear.	Delay of > 1 month ≤ 3 month for deliverables from milestone schedules	< 5% increase to budget allocation	Loss of design margins, some desired science objectives not met: some desired technical performance not completely met
1	Very Low	No impact to personnel or facilities.	Delay of ≤1 month for deliverables from milestone schedule	Minor impact to budget allocations	Small impact to design margins

Table E-2: Likelihood Classification Matrix for Assessment of HRP Risks

Likelihood of Occurrence	Description
5 -Very High (> 90% chance)	Occurrence is very likely and cannot be prevented by existing processes, procedures, and plans; no alternative approaches or processes are available.
4 -High (> 70% chance)	The existing processes, procedures, and plans cannot prevent this event, but a different approach or process may prevent the event.
3 -Moderate (40% to 70% chance)	The existing processes, procedures and plans may prevent this event, but additional actions shall be required.
2 -Low (10 % to 39% chance)	The existing processes, procedures, and plans are usually sufficient to prevent this type of event.
1 -Very Low (< 10% chance)	The existing processes, procedures, and plans are sufficient to prevent this event.

Identify and Assess Risk

1 Start with a Concern. Is this a program risk?
- What information is available? Gather information: requirements status, problem data, trends, hazards, critical items, history, etc.

2 Define Risk Statement.
- Given the condition (A), there is a possibility that (B) shall occur.

(A) – Single phrase briefly describing current key circumstances or situations that are causing concern, doubt, anxiety or uncertainty.

(B) – Consequence or impacts of the current conditions that could be realized due to (A)

3 Define the Consequences (B). Locate the most accurate description(s) among the Safety, Schedule, Cost, and Technical (Mission Success or Supportability) consequence descriptions.

4 How likely is the risk scenario? Locate the most accurate Likelihood description that corresponds to the risk statement. Only one Likelihood score is possible. Note: Quantitative likelihood ratings refer to program lie and are provided as guidelines only.

5 Plot the Risk. Select the highest consequence score. Plot this against the ONE Likelihood score on the RED/YELLOW/GREEN risk matrix.

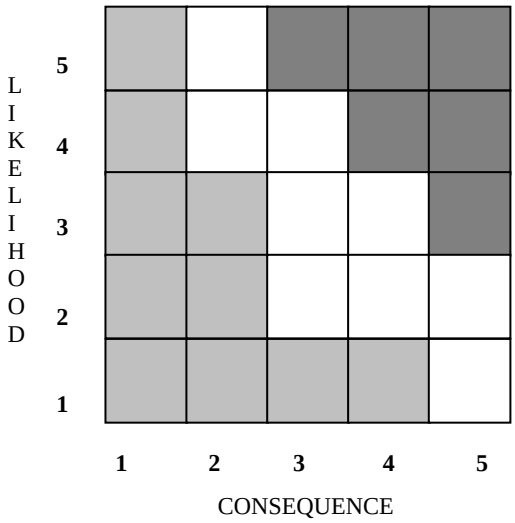


Figure E-3: HRP Risk Management Scorecard in JSC IRMA

E3.2.3 Risk Planning

As new risks are identified and analyzed, the next step is to determine the appropriate approach for responding to those risks: retain responsibility, delegate responsibility, or transfer the risk responsibility to the appropriate team within the organization. Risks are assigned to the appropriate management office, Element, or project for managing all aspects of the risk. The Program Manager may request transfer of a risk to an external organization if that organization is best suited to handle the risk.

Techniques for handling or controlling risks include:

- Avoid: The program, Element, or project plan or approach is modified or not selected in order to avoid or eliminate a risk.
- Mitigate: Eliminate/reduce the risk by performing specific activities that minimize the probability of occurrence and/or severity of the consequence.
- Watch: Monitor the risk and its attributes for early warning of critical changes in impact, probability, timeframe, or other aspects.
- Transfer: Transfer the risk to another program, project, or organization that can more effectively handle the risk or for which the risk has a greater potential impact.

  Accept: Resources are not being allocated for mitigation. HRP is willing to accept the consequences. Accepted Risks will be reviewed periodically to ensure the acceptance rationale is still valid.

The goal of tracking risks is to collect, update, organize, and analyze risk information to provide routine status reports on mitigation activities to the Program Manager.

The HRP uses the JSC IRMA as the common tool database for documenting and tracking all programmatic risks. All risks maintained in IRMA have HRP Management visibility. When appropriate, risks are entered into other risk systems, such as ISS IRMA for all ISS-unique risks.

The HRP uses the HEOMD Quarterly Program Management Review to escalate and track top program risks and those risks that affect other HEOMD programs.

E3.2.5 Controlling Risk

During risk reviews, decisions are made to close risks, escalate/de-escalate risks, continue to research, mitigate or watch risks, re-plan or re-focus actions or activities, or invoke contingency plans. The Program Manager authorizes and allocates resources to reduce risks. Once a risk has been mitigated down to a 2 x 2 on the risk matrix, it may be considered an accepted risk.

Contingency plans are made when necessary to reduce the severity of impact should the adverse event, as identified by the risk, occur. The disposition of risks is reviewed every quarter to determine progress and if the risk handling technique should be changed or if the risk can be closed or accepted.

E.3.2.6 Communicating and Documenting Risk

Successful risk management relies upon:

- Open communication at and among all organizational levels
- Continuously addressing areas that may potentially cause future problems
- Continuously assessing risks and strategies to mitigate those risks

A review of management office, Element, and project status is conducted on a quarterly basis as the technical, cost, and schedule review (TCSR), which includes an emphasis on impacts to program risks and discussion of top PSM, Element, and project risks. During the TCSR, a preliminary programmatic risk review is conducted with program and Element management participants. The purpose of this preliminary review is to briefly discuss the Top Program Risks (TPRs), determine if any Element/project risks should be escalated as program risks, and determine if any other program risks should be escalated as TPRs to the HEOMD. At the first HRPCB following each TCSR, the risk review is held, where proposed changes, escalations, de-escalations, and identification of new risks are dispositioned by the HRPCB.

The HRP Program Manager then reports the TPRs and status to the HEOMD AA during the HEOMD Quarterly Program Management Review (QPMR).

The overall process for communicating the HRP programmatic risks is in Figure E-4.

Currently, there is no capability in JSC IRMA to acknowledge a parent/child or any relationship between risks (capability does exist in ISS IRMA). To identify a parent/child or any risk relationship, the relationship is noted in the "Associated Risks" section. The risk number is entered and the comment/rationale field is updated with the associated relationship.

Although the relationships can be associated for each risk in JSC IRMA, there are no generated reports that list this relationship. Until this issue is corrected, the risk owner can add a reference in the "Impact/Consequence to JSC Program" field as well as included in the "Status" field whenever any relationship/link is established between risks. The reference should be included in both risks involved in the relationship.

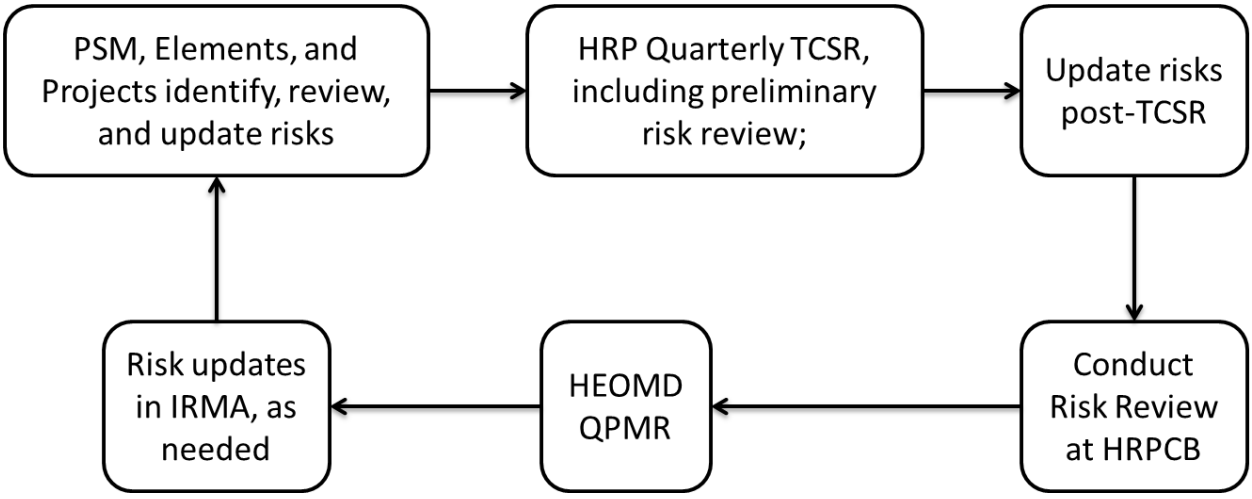


Figure E-4: Risk Communication Flow

APPENDIX F: CURRENT HRP EXTERNAL AGREEMENTS

Current Domestic HRP Agreements				
Subject	**Partners**	**Effective date**	**End date**	**Comments**
Energy Related Civil Space Activities/Space Radiation Health Program	DOE	Jul-1992	on-going	
Vestibular Function	NIH-NIDCD	Oct-1992	on-going	
Neurological Functions	NIH-NINDS	Nov-1992	on-going	
Musculoskeletal Research	NIH-NIAMS	Dec-1992	on-going	
Cardio-vascular, Pulmonary and Hematological Studies	NIH-NHLBI	Sep-1993	on-going	
Space Life Sciences Database	NIH-NLM	Dec-1993	on-going	
Radiobiology Heavy Ion Beam Research	DOE-BNL	Apr-1994	on-going	
Cancer Research	NIH-NCI	Jul-1994	on-going	
Life and Biomedical Sciences	NIH-NCRR	Sep-1994	on-going	
NASA/NSBRI Cooperative Agreement (NCC9-58)	NSBRI	Apr-1997; Oct-2007 Initiated	Sep-2017	
Expertise Exchange in Musculoskeletal and Exercise Physiology	ACSM	Sep-1999	on-going	
Construction of a "Booster Applications Facility"	BNL	Oct-1999	on-going	
Enhance the Application of Remote Sensing and Geographic Information Systems Technology	USGS-EDC	Nov-1999	on-going	
Applications of Robotics to Neuromuscular Adaptations	NIH-NINDS	Feb-2000	on-going	
Collaborations on Workshops and Studies between NASA and NINDS	NIH-NINDS	Mar-2000	on-going	
Enhance the Application of Remote Sensing and Geographic Information Systems to Areas of Infectious Disease Surveillance	NOAA-OGP-OOAR	Apr-2000	on-going	
Space Life Sciences Database-on world wide web	NIH-NLM	Aug-2001	on-going	

Current Domestic HRP Agreements				
Subject	**Partners**	**Effective date**	**End date**	**Comments**
Understanding and predicting the effects and health risks resulting from low-dose, low-influence radiation	DOE-OBER	Jan-2002	on-going	
Non-reimbursable Space Act Agreement for the Cleveland Clinic Center for Space Medicine	Cleveland Clinic	Oct-2004	Oct-2015	
Electron Beam Ion Source (EBIS) at Brookhaven National Laboratory (BNL)	DOE	Feb-2006	Jan-2016	
Flight Food System	DoD-Soldier Systems Center	Dec-2007	on-going	
Concerning Proton Radiation Research	LLU	Sep-2008	on-going	
Non-reimbursable Space Act Agreement with Summa Health Care System for advanced health care delivery to astronauts	Summa Health System	Nov-2010	Nov-2015	
UTMB Test bed Facilities	NIH	Feb-2010	Jan-2015	
Collaboration on the development and review of materials for the NASA Math and Science @ Work and NASAExploring Space Through Math projects	LTF	Aug-2012	Sep-2015	
Non-reimbursable Space Act Agreement with LTF for the development of classroom ready materials (e.g. problems, activities, labs) related to NASA's research programs for use in educator training sessions	LTF	Aug-2012	on-going	

Complete or Retired Domestic HRP Agreements				
Subject	**Partners**	**Effective date**	**End date**	**Comments**
Antarctic Activities	NSF	Jan-1991	on-going	Retired
Infectious Disease Surveillance and Control/Remote Sensing and Disease Predication	CDC-NIDCD	Jul-1995	on-going	Retired
Construction and Operations of High-Energy, Heavy Ion Irradiation Facilities	DOE-BNL	Oct-1997	Oct-2007	Retired
Biomedical/ Behavioral Research	NIH	May-1999	on-going	Retired
Applied Biomedical Research	USUHS	Jul-1999	Jul-2006	Retired
Bibliographic database SPACELINE	USUHS	Nov-1999	Oct-2004	Retired
John Glenn Scholarship for Space Research	AFAR	Jun-2000	on-going	Unfunded
Studies of Sensory-Motor functions Responsive to Gravity in Genetically Altered Model Systems	NIH-NIDCD	Oct-2000	on-going	Unfunded
Plant Research	USDA	Jan-2001	Jan-2011	Retired
Basic plant research, crop production, etc	USDA	Jan-2001	Jan-2011	Retired
Non-reimbursable Space Act Agreement between NASA Lyndon B. Johnson Space Center and Houston Dynamo for Sports and Exploration (SE) Education Partnership (SAA-AT-07-002)	Houston Dynamo, MLS	Jun-2005	Expired	Completed
Non-reimbursable memorandum of agreement between NASA JSC and President’s Council on Physical Fitness and Sports for NASA Fit Explorer and PCPFS Program (Space Act Agreement SAA-AT-07-024)	President's Council on Physical Fitness and Sports	Jun-2005	Expired	Completed
Low Dose Radiation Research	DOE	Jan-2007	expired FY11	Retired
Foster New Areas of Cooperation between USDA and NASA	USDA	Jan-2007	TBD	Retired
Establish Collaborative Science Planning and Cooperative Support in Areas of Mutual Research	NIH-NCRR	Feb-2007	Feb-10	Retired
Validation of Space Radiation Analysis Tools (IA1-872)	LBNL	Oct-2007	Oct-2012	Completed

Current International HRP Agreements				
Subject	**Partners**	**Effective date**	**End date**	**Comments**
Agreement between the USA and the Russian Federation Concerning Cooperation on the Exploration and Use of Outer Space for Peaceful Purposes	Russian Federation	Jun/Jul-1992		
US/Russian Joint Working Group on Space Biomedicine, Life Support Systems, and Microgravity Sciences	Russian Biomedical	Apr-1994	on-going	
International Space Life Sciences Flight Experiments on the ISS (ISLSWG)	ESA-CSA-NASDA	Sep-2002	Dec-2015	Initial agreement ran from Sep-2002 to Sep-2012. An extension was added in Sep-2012.
Pulmonary Function System (PFS) Joint Utilization Plan	ESA	Aug-2006	on-going	
"Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss" & "Pre-flight oledronate Infusion as an Effective Countermeasure for Spaceflight-Induced Bone Loss and Renal Stone Formation"	JAXA	Sep-2006	on-going	
Portable Pulmonary Function System (PPFS) Letter of Agreement	ESA	Aug-2009	Dec-2015	Initial agreement ran from Aug-2009 to Sep-2012. An extension was added in April-2012.
Protocol between NASA and Roscosmos One Year Expedition	Roscosmos	Sept-2012	on-going	
Multilateral Hardware Sharing Principles Document	ESA-CSA-JAXA-Roscosmos	Nov-2013	on-going	

Complete or Retired International HRP Agreements				
Subject	**Partners**	**Effective date**	**End date**	**Comments**
PKINASE & LEUKIN	ESA	Apr-2006	unknown	Completed
ANITA	ESA	Dec-2004	2009	Completed
Artificial Gravity Project	DLR/RAS	Oct-2004	Oct-2007	Retired
(All Female) Long Term Head Down Tilt Bed Rest Study (with Amendment)	ESA-CNES-CSA	Jul-2004	Jul-2009	Retired
NASA's Tissue Equivalent Proportional Counter (TEPC)	ESA	Nov-2003	Nov-2006	Retired
Enabling early utilization opportunities of the ISS	ESA	Mar-1997	Mar-2007	Retired
ESA European Physiology Modules (EPM)	ESA	Dec-1999	Dec-2006	Retired
Ambiguous Tilt and Translation Motion Cues After Space Flight (Z-Aligned Gravitoinertial) and Otolith Assessment During Postflight Re-Adaptation (ZAG/Otolith)	ESA	unknown	unknown	Retired
"H-Reflex" and "EVA Study" projects	CSA	Jan-2000	Until Retired	Retired
Human Orientation and Sensory-Motor Coordination in Prolonged Weightlessness	ESA	Feb-2003	unknown	Deselected
Russian 105-day Chamber Study	IBMP-NSBRI	Jul-2008	Dec-2009	Completed
Consequences of long-term confinement and hypobaric hypoxia on immunity in the Antarctic Concordia environment (CHOICE)	ESA	2007	Sep-2012	Completed